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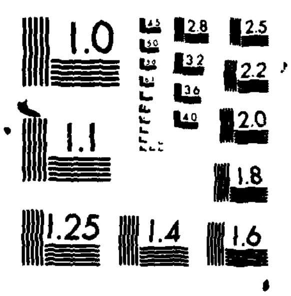

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VOLUME II

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PREDICTION OF SUPERSONIC STORE SEPARATION CHARACTERISTICS INCLUDING FUSELAGE AND STORES OF NONCIRCULAR CROSS SECTION. VOLUME II - USER'S MANUAL FOR THE COMPUTER PROGRAM

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November 1980

TECHNICAL REPORT AFWAL-TR-80-3032, VOLUME II
FINAL REPORT FOR PERIOD JUNE 1975 - JANUARY 1980

Approved for Public Release, Distribution Unlimited

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Detailed instructions are presented for using a computer program which calculates the six-degree-of-freedom trajectories of external stores which are separated from fighter-bomber type aircraft flying at supersonic speeds. Multiple circular or elliptical store configurations may be handled. Parent aircraft configurations may consist of a circular or arbitrary cross section fuselage with ramp external compression inlets, and a wing, pylon, and rack. The program uses linear potential-flow theory to model the wing and pylon loading and thickness. Three-dimensional line sources and doublets are used

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to model circular fuselages and stores. The noncircular fuselage and elliptic store surfaces are modeled with constant source panels. Nonlinear corrections are made to the wing, fuselage, rack, store and fuselage inlet models to simulate shocks. The program also calculates the trajectory of the store as it separates from the aircraft. This report describes the program, presents instructions for preparing input for the program, describes the output from the program, and presents a sample case. The program represents an extension of an earlier program restricted to circular bodies at supersonic speeds written by the present authors and described in AFFDL-TR-76-41.

This volume presents the instructions for preparing input for each of two programs, a sample case for each, and the descriptions of the output cases.

FOREWORD

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This report "Prediction of Supersonic Store Separation Characteristics Including Fuselage and Stores of Noncircular Cross Section," describes a combined theoretical-experimental program directed toward developing a computer program for predicting the trajectory of an external store separated from an aircraft flying at supersonic speed. It represents an extension of previous work covered in AFFDL-TR-76-41 to include more realistic modeling of fuselage shapes including noncircular cross sections and ramp type engine air inlets, and to include modeling store shapes with elliptic cross section with multiple sets of arbitrarily oriented fins. Volume I, "Theoretical Methods and Comparisons with Experiment," describes the theoretical approach and presents extensive comparisons with experimental data. This volume, Volume II, "User's Manual for the Computer Program," presents detailed instructions on the use of the computer program with emphasis on preparation of input data and interpretation of output. Volume III, "Appendices A and B, Details of Program I," provides additional descriptions of the individual subroutines and program variables passed between modules in the first of two programs. Volume IV, "Appendices C and D, Details of Program II," provides additional descriptions of the individual subroutines and program variables passed between modules in the second program.

This work was carried out by Nielsen Engineering & Research, Inc., 510 Clyde Avenue, Mountain View, California 94043, under Contract No. F33615-76-C-3077. The contract was initiated under Project 2403, Task 240305, of the Air Force Flight Dynamics Laboratory. The Air Force Project Engineer on the contract was Calvin L. Dyer, AFWAL/FIGC. The report number assigned by Nielsen Engineering & Research, Inc. is NEAR TR 210.

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LIST OF SYMBOLS

A	panel area
A/B	elliptic axes ratio; vertical over horizontal semi-major axes
C_A	axial-force coefficient, axial force/$q_{\infty_s} S_R$
C_ℓ	rolling-moment coefficient, rolling moment/$q_{\infty_s} S_R \ell_R$
C_m	pitching-moment coefficient, pitching moment/$q_{\infty_s} S_R \ell_R$
C_n	yawing-moment coefficient, yawing moment/$q_{\infty_s} S_R \ell_R$
C_N	normal-force coefficient, normal force/$q_{\infty_s} S_R$
C_Y	side-force coefficient, side force/$q_{\infty_s} S_R$
d	equivalent maximum diameter of store
F_T	thrust force
F_x	total force acting along the store longitudinal axis
g_x	component of the gravitational force acting along the store longitudinal axis
h	integration interval
I_{xx}, I_{yy}, I_{zz}	moments of inertia about x,y,z axes of Figure 17; taken about store moment center
I_{yz}, I_{xz}, I_{xy}	products of inertia about x,y,z axes of Figure 17; taken about store moment center
k_p, k_w	number of breaks in sweep or dihedral in the pylon and wing planforms
ℓ	body length
ℓ_R	reference length; equivalent circular store maximum diameter, $2\sqrt{S_R/\pi}$
ℓ_s	length of separated store
m	mass of separated store
M_∞	aircraft free-stream Mach number

LIST OF SYMBOLS (Continued)

M_{ℓ}	local Mach number at point
MFR	mass flow ratio
p,q,r	rotational velocities about x,y,z axes of Figure 17; positive as shown in Figure 21
q_∞	free-stream dynamic pressure; $\frac{1}{2}\rho_\infty V_\infty^2$
q_{∞_s}	ejected store free-stream dynamic pressure; $\frac{1}{2}\rho_\infty V_{\infty_s}^2$
r	local body radius
s	semispan of wing
S_R	reference area taken equal to store frontal area, ft^2
t	time
t/c	thickness to chord ratio
u,v,w	velocities in coordinate directions of component under consideration
u_+/V_∞	strength of a constant u-velocity panel
U_s,V_s,W_s	total velocities as seen by store, positive in x_s, y_s, z_s directions, see Figure 17
V_x,V_y,V_z	free stream velocity components seen at store moment center due to translational motion of store.
V_∞	aircraft free-stream velocity
V_{∞_s}	separated store free-stream velocity
x,y,z	coordinate system with origin at store moment center, see Figure 17
x_B,y_B,z_B	coordinate system fixed in fuselage with the origin at nose, see Figure 5
x_B',y_B',z_B'	source panel coordinate system fixed in noncircular fuselage or elliptic store with origin at nose, see Figure 6

LIST OF SYMBOLS (Continued)

x_ℓ, z_ℓ	coordinate system fixed in local airfoil section of wing, see Figure 8(b), with x_ℓ lying along chord line
x_s, y_s, z_s	coordinate system fixed in separated store with origin at store nose, see Figure 17
$x_{s,m}$	x_s coordinate of store moment center
x_w, y_w, z_w	coordinate system fixed in wing with origin at root chord leading edge, see Figure 7
α_c	included angle of attack
α_ℓ	local angle of attack due to wing twist and camber
α_s	angle between longitudinal axis of body and vertex of shock at angle of attack
β	$\sqrt{M^2-1}$, Prandtl-Glauert factor
β_I	inlet panel β; input item 29
β_{IS}	β computed for location of inlet shock at a field point
δ	source panel incidence angle
$\delta_{R,L,U,D}$	deflection angle of store fin for right, left, upper, and lower fins (fins 1,2,3,4) respectively; positive trailing edge down
ε_α	angle of attack correction factor for rotation of vertex of body nose shock about the longitudinal axis of the body
$\Delta\nu$	change in flow angle behind shock
ϕ	polar angle of shock traverse
ϕ_I	angle between real store z-axis and the plane containing the image and real store longitudinal axes
ϕ_R	roll angle of included angle of attack
σ	nose cone semi-vertex angle for circular bodies
θ	tan θ, local slope of wing thickness envelope for wing panels, or inclination angle for body source panels

LIST OF SYMBOLS (Concluded)

θ_r	angle of shock reflecting from fuselage measured from fuselage centerline, see Figure C-7, Volume IV
θ_s	local angle of shock; at body nose it is the input limiting value obtained from Chart 5, Reference 9
θ_t	local angle of incidence of surface at shock intersection
ξ,η,ζ	inertial coordinate system fixed in fuselage nose, positive forward along longitudinal axis, positive laterally to the right, and positive vertically downward, respectively, see Figure 21
ρ_∞	free-stream mass density
Ψ,Θ,Φ	store yaw, pitch and roll angles specifying angular orientation of store x,y,z coordinate system relative to ξ,η,ζ inertial system, see Figure 21

<u>Subscripts</u>

$(\ )_B$	body
$(\ )_{cg}$	center of gravity
$(\ )_n$	store nose or n'th subscript
$(\ )_r$	reflected shock
$(\ )_s$	store or shock

PREDICTION OF SUPERSONIC STORE SEPARATION CHARACTERISTICS INCLUDING FUSELAGE AND STORES OF NONCIRCULAR CROSS SECTION

Volume II.- User's Manual for the Computer Program

1. INTRODUCTION

The purpose of this volume of the report is to describe and present instructions for using the two computer programs developed in conjunction with the theoretical work presented in Reference 1. This work represents four year's effort on the development of an analytical method for predicting the trajectory of a store separated from an aircraft flying at supersonic speeds. The present work includes the extension of the work of References 2 and 3 to include the generality of noncircular parent aircraft configurations and an elliptic store with two sets of arbitrary oriented fins. This extends the present work to match the capabilities of the subsonic store separation prediction method and program in References 4 and 5 though different theoretical approaches are taken. Preliminary versions of that method and program are described in References 6, 7, and 8. Because of the program's size, the program has been split into two parts to reduce core requirements and avoid unnecessary repetition of calculations.

In extending the work of References 2 and 3 to noncircular body shapes every attempt has been made to maintain the circular shape options in their original form and to parallel their development with new calculations. Wherever possible two separate and distinct options exist for each of the methods with both producing the same information.

The descriptions of the user information describing the input and execution of the various routines is split into three volumes.

The present volume contains the descriptions of the capabilities of the programs, the descriptions and formats of the input parameters, the descriptions of the output quantities, and examples of input and output. The second volume contains Appendices A and B which provide the detailed descriptions of the operations and equations implemented in each of the subroutines and the definitions of all parameters passed through both labeled and blank common in Program I. The third volume similarly contains Appendices C and D with the detailed descriptions of subroutine operations and parameters passed through common in Program II. All information necessary to specify the input and interpret the output should reside in the present volume.

The two programs as described in this report have been run on the CYBER-175 computer. The programs should run with very little, if any, modification on other computers with large enough memory capacity. The first program requires approximately 250,000 octal words of core storage on the CYBER-175. In addition to INPUT and OUTPUT files six external files are used internally by the first program. Five of these are temporary files in which all information is generated and used internally without direction by the user. The last file TAPE12, is used to store the dataset generated by Program I to be passed to Program II.

Program II requires approximately 372,000 octal words of core storage to run the maximum size case which can be specified by the input on the CYBER-175. In addition to INPUT and OUTPUT files seven external files are used internally by the second program. Six of these are temporary files used internally by the program for temporary storage of data only during the duration of the run. The seventh, TAPE12, is an input file containing the data generated in Program I to be used in Program II. The information on TAPE12 is written unformatted and may be stored on any external device specified by the user. The remaining input to both programs is from cards and all output is printed.

The next sections of this report will describe in more detail the general use of the program and then present instructions for preparing the input data and interpreting the output. A sample case is presented. Details of the program are contained in the appendices in Volumes III and IV.

The method of describing the aircraft components, the aircraft operational parameters, and the dynamical characteristics of the store are of importance. The various parameters which are included in the computer program are:

Wing Panels

Thickness distribution: Specified at a large number of chordwise and spanwise locations independent of the constant u-velocity panel layout used to represent the wing as a lifting surface.

Mean camber surface: May have both twist and camber.

Leading-edge shape: Represented by straight line segments of differing sweep.

Trailing-edge shape: Also represented by straight line segments of differing sweep.

Dihedral: Represented by straight spanwise segments of varying dihedral.

Fuselage

Two optional shapes:

1) Body of revolution represented by line sources and doublets

2) Noncircular general shaped body represented by source panels

Inlet shape: Ramp inlet using oblique shock external compression.

Pylon

Thickness distribution: Same method of description as for wing panel.

Mean camber surface: Planar.

Orientation: Vertical and streamwise.

Leading-edge shape: Represented by line segments of differing sweep.

Trailing-edge shape: Also represented by straight line segments of differing sweep.

Tip: Parallel to pylon root chord.

Number: One pylon per wing panel or one under fuselage centerline.

Rack

Shape: Body of revolution.

Number of racks: One on pylon.

Store

Two optional shapes:

1) Body of revolution represented by line sources and doublets
2) Elliptic body represented by source panels.

Number of stores: Seven of any combination of shapes.

Number of shapes: Maximum of seven bodies of revolution or maximum of two elliptic shapes.

Attached orientation: Initial pitch angle arbitrary, initial yaw angle zero, and initial roll orientation arbitrary.

Empennages:

1) Body of revolution may have one set of planar or cruciform fins
2) Elliptic body may have one or two sets of fins; each set may have one through four fins at arbitrary orientation.

Airplane Operating Characteristics

Flight path: Straight but not necessarily horizontal.

Flight velocity: Constant.

Density: Constant.

Angle of attack: Constant.

Yaw angle: Zero.

Store Inertial Characteristics

Moments of inertia: Constant.

Products of inertia: Constant.

Center of gravity position: Not necessarily on store longitudinal axis.

Store Ejection Conditions

Initial translational velocities: Arbitrary.

Initial pitching velocity: Arbitrary.

Initial yawing velocity: Arbitrary.

Initial rolling velocity: Arbitrary.

Power: Option of specifying a thrust time history.

Ejection: Option of specifying an ejector force versus time or displacement history.

Two analytical methods may optionally be used to compute flow fields around bodies in these programs. For purposes of simplicity of nomenclature the technique employing line singularities will be referred to as the circular body method. Similarly, the use of the source paneling technique for fuselages will be referred to as the noncircular fuselage method. The use of source paneling techniques for store configurations will be referred to as the elliptical store method. In describing the input to the noncircular and elliptic body methods the same variables and input routines have been used for both fuselage and stores. All data required for further calculation are saved on external files via internal program logic.

2. GENERAL DESCRIPTION OF THE USE OF THE PROGRAMS

The store separation trajectory computation at supersonic speeds requires the execution of two programs. The first program, LDCALC, consists of three sections. The first reads the input and control parameters required to specify the parent aircraft and store geometries. The next solves for the singularity distributions which represent the wing-pylon loading including interference on the fuselage, the circular or noncircular fuselage, the rack, and the circular or elliptic stores excluding the empennages. The third section takes the singularity and geometric data required for continuing the calculations and saves it on an external file.

The second program, TRJTRY, consists of three sections. The first reads the file from Program I and the additional data to be used to specify the separating store and its empennages if any. The second section generates the influence coefficient matrices for any empennages that are present. The third section calculates the forces and moments on the separating store and computes the trajectory. This division into two programs allows the user to generate the parent aircraft geometry and singularity strengths once and then compute several trajectories.

2.1 Descriptions of the Use of Program I

The first program is organized in three sections to read parent aircraft and store data, to generate individual body and wing-pylon singularity strengths, and to save required results on an external dataset. A brief description of the information to be input or tasks to be performed in each of the sections follows.

2.1.1 Input Section

The input section of the program reads in the following information.

(1) Parent aircraft flight conditions
(2) Indices specifying what aircraft components are present
(3) Fuselage data
(4) Wing data
(5) Pylon data
(6) Rack data
(7) Store data

The aircraft flight conditions, item (1) above, which can be varied are the angle of attack and Mach number of the parent configuration.

Item (2) consists of four indices. The first specifies whether a fuselage is present and, if so, what type. The second specifies whether a pylon is present and the third index specifies whether a rack is present on the pylon. The fourth index specifies how many stores are present. The program in its present form will handle up to seven stores.

The fuselage input data, item (3) above, is different for each of the fuselage modeling methods. The circular fuselage method requires the length, maximum radius, and polynomials specifying the body radius as a function of axial location. Other input data specify the number of sources and doublets to be used in representing the fuselage volume and angle of attack effects, the fuselage interference panel layout, and locate the nonlinear shock wave from the nose. The noncircular fuselage method requires the elliptic axes or cross-sectional shape distribution as a function of axial location. Other noncircular fuselage data specify the number and locations of panels to be used, the interference

shell layout, and generate the nonlinear shock shape. The panels used to represent the engine inlets, if present, are indicated.

The wing input data, item (4), locate the wing relative to the fuselage and supply information required to lay out separate u-velocity panel and thickness panel distributions. These data include the twist and camber distribution and the slope distribution of the thickness envelope. The wing leading and trailing edges can have breaks in sweep and dihedral.

Similarly, the pylon input data, item (5), locate the pylon and provide information required to lay out the u-velocity panel and thickness panel distributions. The pylon is located laterally relative to the fuselage centerline and longitudinally relative to the leading edge of the local wing chord. The data also include the slope distribution of the thickness envelope. The pylon cannot have twist or camber. The leading and trailing edges can have breaks in sweep.

The rack input data, item (6), are the length, maximum radius, and location relative to local wing chord. Rack incidence relative to the wing root chord is also specified. Also required are the polynomials describing the radius distribution as a function of axial station. Only the line singularity method, circular body method, is available to represent rack volume and angle of attack effects.

Store data, item (7), are input which assign a store number and specify a shape number, length, and maximum radius. Each store is located by specifying its lateral position relative to the fuselage centerline and the longitudinal and vertical position of the store nose relative to the wing chord immediately above the store. The incidence of the store relative to the wing root chord is also specified. The store must be under the fuselage centerline or to the left of this line as seen by the pilot.

Shape numbers less than or equal to 50 are used to denote circular store input, while shape numbers greater than 50 are used to denote elliptical store input. For the circular store, data used to determine the source and doublet distributions to represent the store volume and angle of attack effects are input. These data include the number of singularities and polynomials specifying the store shape. For the elliptic store, data used to determine the body source panel layout are input. These data include the number and locations of the panels covering the body surface. The data used to generate the nonlinear shock shape associated with the store nose are also input.

The strengths of the singularities and the nonlinear shock shapes associated with the presence of the fuselage, rack and stores are computed at the time the data for that particular body are read. Only the geometry variables, singularity strengths, and shock shapes are saved for use in Program II.

2.1.2 Wing-Pylon Loading Section

The second main section of the program calculates the singularity distribution representing the wing-pylon loading including interference on the fuselage. This is done using the method described in Section 3.3 of Reference 1. The right hand side of the matrix equations used to determine the singularity strengths is generated first in order to take advantage of arrays already present in blank common. In determining the influence of the aircraft components at u-velocity panel control points for purposes of the right hand side computation, only the fuselage and wing and pylon thickness effects are included. Their influences based on linear theory are considered, that is, there is no modification due to the presence of nonlinear shocks. No influence due to the rack or stores are considered in determining the wing-pylon boundary conditions.

The coefficient matrix is computed next. The generation of the matrix of coefficients overwrites the existing data in blank common. The solution of the set of simultaneous equations is computed by triangularization of the matrix. The results are the strengths of the constant u-velocity panels divided by π.

Condensation of panel strengths associated with individual panels to net strengths computed for each corner is done last. The net corner strengs are used in Program II to compute wing-pylon influence. For panel layouts where multiple panels lay in the same plane, up to a factor of four reduction in computational effort is achieved.

2.1.3 Dataset Generation Section

The third and last main section in Program I saves the data required for the calculation of the store trajectory in the second program. The geometry and singularity strengths necessary to compute the influence on the separated store of the fuselage, rack and store bodies, of the wing-pylon-interference shell u-velocity panels, and of the wing-pylon thickness panels are written on TAPE12. The data to be transferred for the noncircular fuselage or elliptic stores is transferred from TAPE11 where it is temporarily saved. The entire dataset on TAPE12 must be saved by the user for use in Program II where it may be used for a series of trajectory calculations. The dataset is for a particular aircraft configuration, Mach number, and angle of attack. In Program II calculations can be made for various altitudes and flight path angles. If multiple stores are present, the trajectories of the various stores can be studied. The fin arrangement on the separating store can also be varied as can the store mass and inertia characteristics. If the thrust and/or ejector force options are used, these two force histories may also be varied.

2.2 Descriptions of Use of Program II

The second program is organized in three sections to read the data file, to input additional data for the separating store, and compute the separating store forces and moments and calculate the resulting trajectory.

2.2.1 Input Separating Store Section

The first section inputs the information necessary to define the properties of the separating store. This includes reading the dataset generated in the first program containing the geometry and singularity strengths modeling the parent aircraft components. The input section consists of the following steps:

(1) Input additional titles.

(2) Read parent aircraft and stores file on TAPE12; if either noncircular fuselage or elliptic store data is included, the fuselage data is written to TAPE11 and the elliptic store data is written to TAPE10 for future use.

(3) Read separating store flight conditions.

(4) Read additional information to describe separating store.

The aircraft flight conditions, item (3) above, which can be varied are the angle of attack, flight path angle, Mach number, free-stream air density, and flight velocity. The angle of attack and Mach number must be identical to those used to compute parent aircraft results read in item (2). This is checked in the program and, if it is not true, error messages are written and the program stops. The remaining flight properties may be varied independently in Program II.

The additional data describing the store to be separated include indices specifying the store number, the number of segments into which a circular body is to be broken for the force calculation and the number of sources and doublets, whether the store has empennages, whether it is powered, and whether an ejector is present. Also, the store mass and inertia characteristics are read in along with the location of the point about which the aerodynamic moments are to be calculated. This is the point about which the moments and products of inertia are also calculated. The location of the store center of mass relative to this point is also specified as is the store axial-force coefficient to be used in the trajectory calculation.

Three other indices are input which pertain to options included in the computer program. Provision has been made to include or exclude the damping terms in the velocity field calculations. Also, for a store with an empennage, rolling moment may or may not be included in the acceleration determination. The third option pertains to the calculation of free-flight trajectories as opposed to captive-store trajectories as obtained in the wind tunnel. In wind-tunnel captive-store testing it is customary to change the store pitch and yaw angles to account for translational motion only while measuring the aerodynamic force and moments. This changes its position in the nonuniform flow field. Provision has been made in the computer program to simulate this.

If an elliptic store or noncircular fuselage is included, the data for an elliptic separated store, noncircular fuselage, and one additional elliptic store shape is arranged sequentially in blank common. Up to seven stores of elliptic shape may exist, but there may be only two independent shapes.

2.2.2 Empennage Input and Loading Section

For a store with an empennage, additional quantities must be specified in this section. Separate analytical models for the

empennages are used with each of the circular and elliptical store methods. For the circular store method a single set of planar or cruciform fins is modeled using slender body theory with reverse flow theorems. The additional data are an index indicating whether the empennage is planar or cruciform, the tail-fin semispan, the average body radius in the tail-fin region, the initial roll orientation of the fins, and the lift-curve slope of the fins alone. In addition, the axial position at which the tail forces are assumed to act is specified.

When the elliptic store method is used, two empennages may be modeled using three dimensional u-velocity panels. Each empennage consists of from one to four fins arbitrarily oriented around the body. The additional data required to lay out the panels on the fins and interference shell include the number of spanwise and chordwise rows of panels on each fin and the interference shell; the root chord, the leading and trailing edge sweep angles, and exposed semispan for each fin; and the meridional angle and dihedral angle for attachment of the fin to the body. When breaks of sweep are desired, the additional data for each segment must be supplied.

2.2.3 Trajectory Section

The third and last main section of the trajectory program is the trajectory calculation which consists of the following steps:

(1) Input thrust and ejector force time histories if powered or ejected.

(2) Initialize for trajectory calculation.

(3) Calculate aerodynamic forces and moments.

(4) Calculate accelerations and rates of change of orientation angles.

(5) Integrate equations of motion.

(6) Repeat steps (3), (4), and (5) to end of trajectory.

For a powered store, a series of polynomials is used to specify the thrust history. If a forced separation is selected, a similar input is prescribed for the ejector force.

In the trajectory initialization certain store separation conditions are specified. These are the initial translational velocities and rotational velocities.

The integration of the equations of motion is done by a standard numerical integration technique with the aerodynamic forces and moments calculated at each point required by the integration scheme. The calculation of the nonuniform velocity field and the resulting forces and moments is described in Sections 5 and 6 of Reference 1.

For a given aircraft-store combination and Mach number, it can be seen that a series of trajectories can be run with only minor changes to the input data deck. For example, the aircraft flight path angle can be varied by changing one number on one card. The altitude can be varied by changing the free-stream density and possibly the free-stream velocity to account for changes in the speed of sound. Among other things easily varied are the store mass and inertia properties, center of gravity location, and ejection conditions.

Provision has also been made for restarting a trajectory. This is accomplished by changing one card which specifies the initial and final times and adding two cards specifying the current values of the dependent variables. These are tabulated in the output at each integration step.

3. DETAILS OF THE USE OF PROGRAM I

The first program used to generate the parent aircraft geometry and singularity strengths consists of a main program and 59 subroutines. Appendix A of Volume III presents a detailed description of the calculations in each of these routines. Table A-1 in Appendix A lists these subroutines in alphabetical order and gives a one-sentence description of what each subroutine does. A listing of the routines in Program I is presented in Figure A-1. A general flow chart of the main program for Program I (LDCALC) is presented in Figure 1 of this volume. The program as written in Figure A-1 adheres to ANSI FORTRAN standards. Only the first card is specifically for the CYBER-175 series machines. The program should run with only its removal on other machines. The following sections outline the flow of calculations as presented in the flow chart of the main program, LDCALC, the preparation of input cards, the descriptions of the output, and any special conditions and messages encountered within the program.

3.1 General Flow Chart for Program I

The purpose of the first program is to read the geometric input necessary to define the parent aircraft components and store bodies. It computes the strengths of the singularities associated with volume and angle of attack effects for each of the components.

A general flow chart of the first program is presented in Figure 1. Constants are defined and heading information is read and printed. The aircraft flight conditions are input as are indices specifying what aircraft components are present. If a circular fuselage is present, the fuselage data are read and printed in subroutine FUSEIO. This routine also calls BDYGEN and SHKSHP to calculate the source and doublet distributions which represent the

fuselage volume and angle of attack effects and generate the nonlinear nose shock shape. If a noncircular fuselage is present, the fuselage data is read and printed in subroutine WDYBDY. This routine also lays out the panel geometry in GEOM, solves for their strengts in VELCMP and SOLVE, and generates the nonlinear nose shock shape in BSHOCK.

The next steps in the program read in the data required to model the wing. The data locating the wing are first read and then subroutine SWNGIN is called. This routine reads in the data required to lay out the constant u-velocity panels which will represent the loaded wing. In addition it reads in the twist and camber distribution at the panel control points. Subroutine WLYOUT is called to lay out the panels. The last wing input data is the thickness distribution. These data are read in by subroutine WITHIN.

A check is made in the program to determine whether or not a pylon is present. If one is, subroutine PLYOUT is called to read in the data required to lay out the constant u-velocity panels which will represent the pylon loading This routine also lays out the panels. Subroutine PYTHIN is next called to read in the pylon thickness data.

The next two steps in the program are calls to subroutines THKOUT and THKLYT. These two routines, respectively, print the input data for the wing and pylon thickness and lay out the thickness panels.

A check is then made to see if a fuselage is present. If the circular fuselage is present, subroutine BLYOUT is called to lay out the constant u-velocity panels on the fuselage interference shell. If the noncircular fuselage is present, subroutine BLYOT2 is called to lay out the constant u-velocity panels on the fuselage interference shell.

If a rack is present, subroutine RACKIO is called to read the rack input, compute its volume and angle of attack effects, and nonlinear nose shock shape. The rack is then located in the fuselage coordinate system.

Provision has been made for not including a store in the input data. This has been done so that the program can be used to determine the coordinates of the points at which the wing twist and camber distribution must be input. These points are the control points of the wing constant u-velocity panels. Their locations in the wing coordinate system are calculated and output by the computer program. Some computer time can be saved by making a run without any stores present. The next step in the program checks to see if there are stores. If there are none, the store input section of the program is bypassed. If there is at least one store, subroutine STORIO on the second page of Figure 1 is called to read in and print all of the store data. The type of data used to model the store is determined from the store shape number read. If the shape number, NSHAPE, is less than 51, the circular body method is used and the data consist of the location and incidence of the store and polynomials specifying its shape. For this shape subroutines BDYGEN and SHKSHP are called to compute the source and doublet distributions which represent the store volume and angle of attack effects and the nonlinear nose shock shape. If the shape number is greater than 50, the elliptical store method is used and the data consist of elliptic semi-axes versus axial station and the additional control integers and variables to lay out the source panels on the store surface. Subroutine GEOM is called only once for each different elliptic shape read. The source panel strengths are computed for all elliptic stores. The nonlinear nose shock shape is computed only at zero degrees angle of attack for each different store shape. Following this all the stores are located in the fuselage coordinate system.

The next five boxes of Figure 1(b) are associated with the calculation of the strengths of the constant u-velocity panels to represent the wing-pylon loading including interference effects on the fuselage. The equations used to solve for the strengths are given in Section 3.3 of Reference 1. The first step is to call subroutine DPRHS which calculates the right-hand side of this set of simultaneous equations. The next step is to call subroutine DPCOEF which calculates the coefficient matrix, that is, the coefficients multiplying the unknown panel strengths divided by π, $(u_{+}/V_{\infty})/\pi$. The resulting set of equations is then solved by calling subroutine INVER1. The next section of the program prints the resulting panel strengths, control point coordinates, and interference velocities at these points. Since up to four panels may share the same corner, subroutine NULYT is called to sum the net strengths at panel corners. This increases the calculative efficiency of the u-velocity panel influences in the second program. The same summing up is also done for the thickness panels.

The last step in the first program is to save the data file required to run Program II. The call to subroutine WRFILE writes all parent aircraft geometry, singularity strengths, and control variables, including the store body data onto TAPE12. The user is responsible for disposition of this dataset. All information is written unformatted.

3.2 Input Data

This section of the report will describe in detail the preparation of the input data deck for Program I, LDCALC. Program I reads the data required to compute the singularity strengths modeling all components of the parent aircraft configuration. Data which are repeated in both Programs I and II will be noted. All remaining data are passed from Program I to Program II via an external file to be described later.

Two analytical methods may optionally be used to compute flow fields around bodies in these programs. For purposes of simplicity of nomenclature the technique employing line singularities will be referred to as the circular body method. Similarly, the use of the source paneling technique for the fuselage will be referred to as the noncircular fuselage method. The use of source paneling techniques for store configurations will be referred to as the elliptical store method. In describing the input to the noncircular and elliptic body methods the same variables and input routines have been used for both fuselage and stores. All data required for further calculations in Program I are saved on external files via internal program logic. The data required by Program II are written to TAPE12 at the end of Program I.

3.2.1 Input Formats

The format for the input data for Program I is shown in Figure 2. Four lines of information are shown for each item. The first line gives the item number, how many and when the cards are read, and the routine in the program in which data are to be read. The second line gives the program variable names, the third line shows the card column fields into which the data are to be punched, and the fourth line shows the FORTRAN format type. Data punched in I and E formats are right justified in the fields whereas data in F format can be punched anywhere in the field. A decimal point should be included in both E- and F-type data. The C format designation in columns 73 through 80 indicates that the fields in the second line are comments not read by the program.

3.2.2 Input Descriptions for Program I

The following are the descriptions of the variables to be read in Program I for each of the items shown in Figure 2.

Item number 1 is an index NCARDS which indicates how many cards of information are to follow to identify the run. The value of NCARDS must be one or greater.

Item number 2 is a set of NCARDS cards containing hollerith information identifying the run and may start and end anywhere on the card. The cards are reproduced in the output just as they are read in.

Item number 3 consists of one card and contains the following information:

ALFAC	fuselage angle of attack, degrees
FMACH	Mach number

These are the values associated with the parent aircraft used in both Programs I and II. These parameters are again read in Program II and compared with the values read here. If they do not agree, error messages are written and Program II stops. The Mach number should be between 1.2 and 3.0 and the angle of attack should not exceed 10°. The wing-fuselage flow model is valid within these limits.

Item number 4 contains four indices which specify what aircraft components are present. They are

NFU	fuselage?	NFU=0, no NFU=1, yes - use circular fuselage method NFU=2, yes - use noncircular fuselage method
NPY	pylon?	NPY=0, no NPY=1, yes
NRACK	store rack?	NRACK=0, no NRACK=1, yes

NSTRS	store?	NSTRS=0, no
		NSTRS=1 to 7, yes - total number of stores

Provision has been made for omitting the fuselage. For cases with no fuselage the reference coordinate system is fixed at the wing root chord leading edge and ALFAC should be the wing angle of attack. The present version of the program is limited to seven circular stores of different shapes. For elliptic store shapes, however, the program is limited to two different elliptic shapes for which there may be multiple stores of the same size and shape. A total of seven stores are permitted. When elliptic and circular stores are mixed, two elliptic shapes may be present with as many circular shapes as available up to a total of seven stores. The number of stores can be zero. In addition, the program can also be used as an aid in determining the points on the wing and pylon at which the slopes of the camberline and thickness distribution are to be input. This was discussed in Section 3.1.

Items 5 through 10 are input only if the circular fuselage method is selected, that is, NFU=1. For all other options, NFU=0 or 2, these items are omitted from the input deck.

Item number 5 consists of three fuselage quantities which follow and are read only if NFU=1.

FLTHC	length of fuselage, ℓ, feet
FRMAX	maximum fuselage radius, feet
FTHSHK	maximum nose shock wave angle, degrees

The latter angle is used as the limiting value at the tip of the nose in generating the modified shock wave shape. It is obtained from Chart 5, Reference 9, as a function of the semiapex angle of the nose tip. Should the cone angle result in a detached shock, the maximum attached shock angle should be used.

The next three items of input, items 6, 7, and 8 of Figure 2, describe the circular fuselage shape. They are

Item 6:

NFPOLY number of polynomials specifying circular fuselage shape, $1 \le \text{NFPOLY} \le 7$

Item 7:

FXEND(J) x/ℓ of end points of polynomials specifying fuselage shape, NFPOLY values

Item 8:

FCOEF(J,K) coefficients of polynomials specifying shape, K = 1,2,...7

These data specify the radius distribution of the fuselage and are used in the calculation of the source-sink distribution which represents the fuselage volume and the doublet distribution which represents the fuselage angle of attack effects. Up to seven polynomials may be used. The polynomial programmed is

$$\frac{r}{\ell} = C_1 + C_7 \sqrt{C_2\left(\frac{x}{\ell}\right)^2 + C_3\left(\frac{x}{\ell}\right) + C_4} + C_5\left(\frac{x}{\ell}\right) + C_6\left(\frac{x}{\ell}\right)^2 \tag{1}$$

where C_1 through C_7 are the coefficients, r is the local fuselage radius, and ℓ is the fuselage length of Item 5. The polynomials must be input for shapes which are made dimensionless by the body length since the trajectory program is written assuming this to be the case.

Item 6 specifies the number of polynomials. Item 7 consists of one card which contains the NFPOLY values of the end points of the polynomials describing the shape. The decimal point can be placed anywhere in the ten-column field.

Item number 8 is a set of NFPOLY cards specifying the values of the coefficients of the polynomials, Equation (1). All seven coefficients are input even though some of them may be zero.

Items 9 and 10 specify the body interference panel layout and the number of line sources and line doublets to be used to model the fuselage volume and angle of attack effects. The various quantities are

Item 9:

NCWB	number of rings of body interference panels
NBDCR1	number of panels in a ring lying above the wing on the left half of the fuselage
NBDCR2	number of panels in a ring lying below the wing on the left half of the fuselage
NFSOR	number of line sources and line doublets to be used over the fuselage length

Item 10:

BODYPL	length of fuselage over which body interference panels are to be placed, feet

The definitions of some of the above quantities can be clarified by the use of Figure 3. In this simplified layout there are five rings of body interference panels, NCWB=5, laid out over the length BODYPL. In each of the rings one panel, NBDCR1=1, lies above the wing $z_w = 0$ plane and three panels, NBDCR2=3, lie below this plane. Some general rules for determining the input values of these quantities will now be given.

First, consider the length BODYPL. If the wing trailing edge is supersonic, that is, the component of the free-stream Mach number perpendicular to the trailing edge is greater than one,

body interference panels should be laid out over the wing root-chord length, CRW, in Figure 3. For a subsonic wing trailing edge (perpendicular Mach number less than one), body interference panels should extend to the x_w coordinate of the wing tip-chord trailing edge. If the base of the store being separated is behind the point selected using the preceeding rules then the body interference panels should be extended to the x_w location of the store base. When a large rearward axial motion of the store is expected during its trajectory, the body panels should be extended aft to cover this motion.

The number of rings of body interference panels and the number of panels in each ring are defined as follows. The number of rings is dependent on the number of panels in a chordwise row on the wing, NCW. This quantity is input as part of item 36 and its selection will be discussed later. Since, if at all possible, the same number of chordwise panels should be used on both the body and the wing, over the wing root-chord region, CRW in Figure 3, the number of rings of body panels can be found using the following relation

$$NCWB = NCW \left(\frac{BODYPL}{CRW}\right) \tag{2}$$

The value of CRW is determined as described under the item 35 input data. In the above expression, the value of BODYPL should be adjusted so that NCWB is an integer.

Two rules can be given for selecting the number of panels in a ring on the left side of the body. If the store to be separated is under the fuselage at least eight panels should be used. If the store is under the wing, six panels is probably sufficient. The two input parameters specifying the number in a ring are NBDCR1 and NBDCR2. These are the number of panels above and

below the wing $z_w = 0$ plane of Figure 3. Assume that six panels are to be used in a ring, for example. Then, the values of NBDCR1 and NBDCR2 for three specific wing positions are:

Mid-wing

NBDCR1 = NBDCR2 = 3

Wing tangent with top of fuselage

NBDCR1 = 0, NBDCR2 = 6

Wing tangent with bottom of fuselage

NBDCR1 = 6, NBDCR2 = 0

For wings located intermediate between the mid-wing and high or low wing positions, the panels should be divided above and below the wing so that the panel widths are as equal as possible.

The computer program as documented in this report limits the total number of constant u-velocity panels, including interference panels, on the fuselage, wing and pylon in two ways. It is first limited by array dimensions to a maximum of 200 panels with no more than 20 in a ring on the fuselage. Thus, the following relations must be satisfied.

$$\begin{aligned} &(\text{NBDCR1} + \text{NBDCR2}) \leq 20 \\ &\text{NCWB}*(\text{NBDCR1} + \text{NBDCR2}) + \text{NCW}*\text{MSW} + \text{NCP}*\text{MSP} \leq 200 \end{aligned} \tag{3}$$

Secondly, the technique used to consolidate panel strengths at corner points adds additional constraints which are a function of the number of breaks in sweep or dihedral on the wing, k_w, and the number of breaks in sweep on the pylon, k_p. Thus, the following relations must also be satisfied.

$$\text{MSW} + k_w + \text{MSP} + k_p + 2(\text{NBDCR1} + \text{NBDCR2}) + 2 \leq 100 \tag{4}$$

and

$$(MSW+k_w+1)*(NCW+1) + (MSP+k_p+1)*(NCP+1)$$
$$+ 2(NBDCR1+NBDCR2)*(NCWB+1) \leq 500 \quad (5)$$

The variables NCW and MSW are input in item 36 and the variables NCP and MSP are input in item 44 and have individual limitations defined there. The number of wing and pylon breaks may be determined from the number of changes in sweep or dihedral in items 37 and 45, respectively.

The last input variable in item number 9 is NSFOR, the number of line sources and line doublets to be used to model the fuselage volume and angle of attack effects. The general rule to use in determining NFSOR is that the distance between the origins of successive sources or doublets should be approximately equal to the chordwise length of the wing constant u-velocity panels at the root chord. Therefore

$$NFSOR \cong NCW \left(\frac{FLTHC}{CRW}\right) \leq 100 \quad (6)$$

The maximum value of 100 is imposed by dimension statements in the program. The fuselage length, FLTHC, was input as part of item 5. The wing root chord length, CRW, will be input as part of item 35 and the number of chordwise panels, NCW, will be input as part of item 36.

Items 11 through 33 describe the fuselage when the noncircular fuselage method is selected and are included only if NFU=2.

The first five items define general information about the body size, the interference shell, and set execution and print options. Two sets of geometric information are input to define the fuselage shape and lay out the panels on the surface. The

first, items 16 through 25, define the external shape of the fuselage to as great a resolution as the user desires. Items 26 through 32 are then used to specify the subdivision of the external shape into discrete surface panels. The panel coordinates are generated from interpolation in the coordinates specified or computed for the external shape. The number of panels meridionally or axially may be less than, equal to, or greater than specified in items 16 through 25.

The coordinates used in the definition of the source panels are different from the fuselage body coordinates shown in Figures 3 and 5. For the purposes of laying out the fuselage source panels all input will be defined for the right half of the configuration as shown in Figure 6 with the axial direction positive aft from the nose, the y-direction positive out the right wing, and the z-direction positive up.

Items 11 and 12 are used to determine the modified shock wave shape and to lay out the body interference panels.

<u>Item 11</u>:

FLTHC	length of fuselage, feet
FRMAX	maximum lateral dimension of fuselage, feet; used as radial location for first shock wave shape traverse
FTHSHK	maximum nose shock wave angle, degrees
BODYPL	length of fuselage over which body interference panels are to be placed, feet

<u>Item 12</u>:

NCWB	number of rings of body interference panels

See items 5, 9, and 10 for further definitions of these variables, except FRMAX.

Item 13 consists of one card with the alphanumeric description for the noncircular fuselage definition.

In items 14 through 33 columns 73-80 have been left open for user comments and will be used here to designate card names.

Item 14 defines some of the optional print and execution parameters associated with the source paneling of the noncircular fuselage.

IXZSYM symmetry option; for the fuselage input IXZSYM=0
- =0, configuration is symmetric; only half of the body is paneled
- =1, configuration is symmetric; panel both halves of body from data of first half
- =-1, configuration is asymmetric; data for both halves are input

IPRT optional print control parameter
- IPRT(1)=0, do not print copy of input data
- IPRT(1)=1, print formatted copy of input data
- IPRT(2)=0, do not print supplementary geometry data
- IPRT(2)=1, print panel geometry, angles, and areas
- IPRT(3)=0, do not print modified shock wave shape
- IPRT(3)=1, print modified shock wave shape in BSHOCK
- IPRT(4)=0, not used
- IPRT(5)=0, do not print velocity and source strength output
- IPRT(5)=1, print source strengths and velocities used in boundary condition associated with each panel

IUVW component velocity influence coefficient calculation option. <u>For the fuselage, input IUVW=1.</u>

IUVW=0, yes

IUVW=1, no

NSHOCK controls number and where modified shock wave shape traverses are made

NSHOCK=0, a single traverse is calculated at 90°, the side of the fuselage; circular symmetry is assumed

NSHOCK=positive, NSHOCK equally spaced shock traverses are computed between 0° and 90°; no symmetry assumed

NSHOCK=negative, NSHOCK traverses are computed at input values of PHIS(K), K=1,|NSHOCK| in item 33; no symmetry assumed

$|NSHOCK| \leq 100/MAXSHK$

MAXSHK maximum number of integration steps in radial direction used to generate nonlinear shock shapes

NINLET number of open inlet panels; NINLET=0 if no inlet

NINBLK number of fully blocked inlet panels; NINBLK=0 if no inlet

NINVEL number of additional panels used in inlet velocity calculation; NINVEL=0 if no inlet

$NINLET+NINBLK+NINVEL \leq 25$

The parameter IXZSYM is to allow the user to model only half of the body, the full body from the geometry of only the right hand side, or a full nonsymmetric configuration. Since the fuselage assumes symmetry about the centerline, only the right hand side is modeled. The print controls, IPRT, are used to control output during execution. The output from the input phase

is used to echo the data read. The geometry output includes the panel coordinates, control points, areas, and inclination angles and may be necessary in laying out inlet input to confirm panel index numbers. The shock output includes the nose and inlet shock shape output. The velocity print control is used only to examine the influence coefficient matrix. The last print control is used to display the panel strengths and boundary conditions. The parameter IUVW is used to suppress the storage of the component velocity coefficient arrays. These are only required during the calculation of panel pressures and loads. These are not needed for the fuselage but are required to calculate loadings on the separating store. The number of nose shock shape traverses, NSHOCK, allows the user to specify the traverses which best describe the nonlinear shape of the shock in the meridional direction or allow the program to specify an even spacing. MAXSHK limits the number of points in each radial traverse to minimize computing time and also acts as the internal first dimension in the X and R arrays containing the shapes of the nose and inlet shocks. It should be sufficient to allow enough points to be computed to describe the shape.

For the fuselage, the suggested values of the above parameters to use are IXZSYM=0, IPRT(1)=IPRT(2)=IPRT(3)=IPRT(5)=1, IPRT(4)=0, NSHOCK=3, and MAXSHK=8. The parameter IUVW is set internally to one to avoid unnecessary calculations. The card is designated the IOPTS in columns 73-80.

The number of open inlet panels, NINLET, is determined from the layout over the face of the inlet for panels which allow unimpeded flow. This is the number of panels assigned special properties in items 28 and 29 during the solution for panel strengths. NINBLK is the number of fully blocked panels laid over the face of the inlet. This is the number of panels assigned special properties in items 28 and 29 which are used to model the portion of the flow blocked for mass flow ratios less than one. NINVEL is the number of additional panels adjacent to the inlet

panels which are to be used in the flow field calculations used to locate the inlet shock shape. The rules for selection of these panels are given in item 28. The combined numbers of NINLET+NINBLK+NINVEL must be less than or equal to 25.

Item 15 specifies several variables which locate the body interference shell and modified shock wave shape.

XPIB the fuselage x-station at which the fuselage cross-sectional shape defines the body interference shell shape.

XSHLDR the fuselage x-station which is considered to be the "shoulder" of the body nose. If set equal to zero, the value is computed from the location of the first occurrence of a maximum in the cross-sectional area.

EALPHA angle of attack correction used in rotating the body nose shock wave relative to the fuselage axis.

The body interference shell lies on a cylinder (not necessarily circular in cross section) of constant cross section over its axial length. The Y,Z geometry defining the surface of the shell is taken to be equal to the Y,Z body coordinates at a specified x station. That station is designated by XBIP. It is necessary that the shell be either on or outside the body source panels so as to avoid using the panel solution associated with the inside of the source panel. Therefore, the body x station for XBIP should be that at which the largest lateral dimensions of the source panels occur.

The specification of the shoulder x-location, XSHLDR, is only meant to provide a reasonable estimate of the point where the nose stops increasing in area. It is used only to estimate the aft point where the modification of the shock wave shape

returns to the original linear theory value. Typical locations of XBIP and XSHLDR are shown pictorially in Figure 6.

The parameter EALPHA defines the amount of deviation from a straight rigid rotation of the body nose shock wave about the nose. The angle from the axis of symmetry of the nose shock to the body centerline is thus defined as $\alpha_s = \alpha_c(1\text{-EALPHA})$. EALPHA is limited to values from 0.0 to 1.0 representing the range of rigid shock rotation to no shock rotation with angle of attack. The value of EALPHA for circular cones may be determined as a function of Mach number and nose semi-vertex angle, σ, from Table 14 in Reference 10. A plot of the information in Table 14 is also found in Figure 4 of this report. In lieu of better information for noncircular shapes use the vertex angle of an equivalent circular cone. This card is designated XBIP in columns 73-80.

Item 16 contains the control integers used to specify the type and the amount of input used to define the fuselage external geometry. The variables defined here and in the next nine items control the specification of the external body shape.

J0	Read reference area card; for fuselage, J0=0 J0=0, do not read item 17 J0=1, yes, read item 17
J2	integer flag indicating type of data describing the fuselage external geometric shape J2=+1, data for arbitrary shaped body to be entered; include section data in items 20 and 21 J2=-1, data for circular body in form of cross-sectional areas versus XFUS (item 18) to be entered; include section data in item 22 J2=-2, data for circular body in form of radius versus XFUS to be entered; include section data in item 23

J2=-3, data for elliptic body to be entered in form of semi-axes in y- and z-directions; include items 23 and 24

J2=-4, data for elliptic body to be entered in form of vertical semi-axis, A, and elliptic ratio, B/A; include items 24 and 25

J2=-5, data for elliptic body to be entered in form of horizontal semi-axis, B, and elliptic ratio, A/B; include items 23 and 25

J6 — integer indicating whether body centerline is cambered

J6=0, body is cambered; if $J2<0$, include item 19; if J2=+1, J6 must be input as 0

J6=$\pm$1, body is uncambered; omit item 19

NFUS — number of axial body segments; $1 \le \text{NFUS} \le 5$

NRADX(I) — number of points in Ith body segment used to specify points on cross section about the periphery; $1 \le I \le \text{NFUS}$. If the configuration is symmetric (IXZSYM=0,1), NRADX is input for the half section. If the entire configuration is input (IXZSYM=-1), NRADX is input for the full section. If the body is circular or elliptic, the program computes NRADX Y- and Z-ordinates about the section. $\text{NRADX(I)} \le 33$.

NFORX(I) — number of axial stations in Ith body segment at which external geometry is specified;

$$1 \le I \le \text{NFUS}, \quad \sum_{I=1}^{\text{NFUS}} \text{NFORX(I)} \le 51.$$

The quantities NRADX(I) and NFORX(I) must be input in pairs.

The reference area read under J0=1 may also be read later for K0=1 in item 30. For the fuselage, J0=0 and K0=0 should be used since no force or moment coefficients are computed. The input items required for the combinations of J2 and J6 are shown in the following table.

Required Inputs for J2 and J6 Options

J2	J6	Required Variable Quantities	Item Numbers
1	0	XFUS, Y, Z	18, 20, 21
-1	±1	XFUS, FUSARD	18, 22
	0	XFUS, ZFUS, FUSARD	18, 19, 22
-2	±1	XFUS, FUSBY	18, 23
	0	XFUS, ZFUS, FUSBY	18, 19, 23
-3	±1	XFUS, FUSBY, FUSAZ	18, 23, 24
	0	XFUS, ZFUS, FUSBY, FUSAZ	18, 19, 23, 24
-4	±1	XFUS, FUSAZ, B/A	18, 24, 25
	0	XFUS, ZFUS, FUSAZ, B/A	18, 19, 24, 25
-5	±1	XFUS, FUSBY, A/B	18, 23, 25
	0	XFUS, ZFUS, FUSBY, A/B	18, 19, 23, 25

The quantities NRADX and NFORX specify the number of points in the meridional and axial directions per segment to be input or computed to define the external fuselage shape.

The value NRADX for the Ith segment remains constant for all sections within that segment. For J2=1, NRADX represents the number of y,z pairs per section which are input. Long constant geometry sections need only be defined once at each end. The values of NRADX and NFORX may vary from segment to segment. NRADX and NFORX should be greater than or equal to KRADX and KFORX defined later to avoid paneling that lies inside the actual external geometry shape. When used to define the actual panel layout they should follow the rules for KRADX and KFORX. KRADX and KFORX are defined in item 27. The choice of NFORX(I) must

further satisfy the constraint that their sum for all segments must also be less than or equal to 51. In selecting the number of axial stations for multiple segment layouts, the sections at the segment interfaces are counted twice. They are counted as the trailing stations of the forward segments and as the first station of the aft segments.

This card is designated JCARD in columns 73-80.

Item 17 contains the fuselage reference area. It is input only of J0=1 in item 16. It may be redefined by item 30. If not defined, REFA is set equal to 1.0. Since fuselage forces and moments are not calculated, J0 in item 16 should be input as J0=0. If this is done this input item is skipped. This card is designated REFA in columns 73-80.

The values in items 18 through 25 define the external shape of the fuselage as dictated by the previous control variables. This complete set of items is repeated for each of NFUS fuselage segments as required. Segment descriptions must be given in order of increasing values of x.

Items 18 and 19 specify the x and z values of each axial station in the Kth segment as follows. NFORX(K) values are input for each item.

Item 18:

XFUS(I,K) — axial station at which body cross section data is included, feet; K=1,NFUS; I=1,NFORX(K)

Item 19:

ZFUS(I,K) — input this item only if J2<0 and J6=0 (see item 16). z-value of camber offset, feet; K=1,NFUS; I=1,NFORX(K)

The values of XFUS define the axial stations at which subsequent section data are input. The first value of XFUS (=0.0) must start at the body nose. All values must increase monotonically to the last value within a segment, XFUS(NFORX(K)) for the Kth segment. These values are shown pictorially in Figure 6. When multiple segments exist, NFUS>1, the values at the last x station of NFORX(K-1) segment must be repeated as the first station of the NFORX(K) segment. For circular or elliptic sections, the body external shape at a given x station is described first by the y,z coordinates of the shape with respect to a local "centerline" and then by the offset of this local "centerline" with respect to the body axis. This is the camber offset, ZFUS. The cards are designated the XFUS and ZFUS cards in columns 73-80.

If J2, item 16, is equal to one, NFORX(K) sets of items 20 and 21 are included in pairs. They define I descrete points on the surface of an arbitrary body as follows:

Item 20:

Y(I,J,K)	y_B'-ordinates of arbitrary body at Jth section in Kth segment, feet; I=1,NRADX(K), J=1,NFORX(K), K=1,NFUS

Item 21:

Z(I,J,K)	z_B'-ordinates of arbitrary body at Jth section in Kth segment, feet; I=1,NRADX(K), J=1,NFORX(K), K=1,NFUS

NRADX(K) values of first Y, then Z, are input to define the half configuration (IXZSYM=0 in item 14) as required for each station. When ordering the points, the first value starts on the vertical plane of symmetry at the bottom (Y=0, Z-negative) and proceeds counterclockwise about the body when looking upstream. If the full section is input, the first and last values must be identical in order to close the body. A typical section is shown in Figure 6

for J2=1. The cards are designated YJ and ZJ where J is the axial station number in columns 73-80.

If J2, item 15, is less than zero, user requested combinations of items 22 through 25 are used to define the circular or elliptic shape for the Kth segment as follows:

Item 22:

FUSARD(I,K) cross-sectional area of circular body, square feet; I+1,NFORX(K); K=1,NFUS

Item 23:

FUSBY(I,K) for J2=-2, radius of circular body, feet; for J2=-3 or -5, length of horizontal semi-axis, B, of an ellipse, feet; I=1,NFORX(K); K=1,NFUS

Item 24:

FUSAZ(I,K) length of vertical semi-axis, A, of an ellipse, feet; I=1,NFORX(K); K=1,NFUS

Item 25:

ERATIO(I,K) for J2=-4, elliptic ratio B/A; for J2=-5, elliptic ratio A/B; I=1,NFORX

These combinations of variables define the possibilities of specifying the standard circular and elliptic shapes at each axial station. The permitted combinations of these items are given in the table for item 16. When defining an elliptic shape (J2=-4 or -5) using one of the semi-axes and the elliptic ratio, only the first value of the elliptic ratio has to be defined. All subsequent values equal to zero (not defined) are set equal to the previous value. The elliptic ratio may assume a new value at any or all stations. A typical section is shown in Figure 6 for J2=-3. These cards are designated FUSARD, FUSBY, FUSAZ, or A/B in columns 73-80, respectively.

Item 26 contains one card with any desired identifying information relating the paneling sequence to the previous external geometry shape.

Item 27 defines the control variables used to specify the resolution of the configuration into source panels. This card is similar to item 16 with the difference that it defines the layout of the source panels themselves as follows:

K0 — read reference area and length card; for fuselage, K0=0

- K0=0, no exclude item 30
- K0=1, yes, include item 30

KRADX(I) — number of meridian lines in Ith segment used to define panel edges (I=1,NFUS). There are three options for specifying the number of panel edges. $-33 \le KRADX \le 33$.

- KRADX(I)=0, number of meridians is set equal to NRADX(I)
- KRADX(I)=positive number; the meridian lines are calculated at KRADX(I) equally spaced angles about the body
- KRADX(I)=negative number; the locations of meridian lines are input at KRADX(I) values of PHIK in item 31

KFORX(I) — number of axial stations used to define leading and trailing edges of panels in Ith body segment. Three options are available

- KFORX(I)=0, the number of axial stations is set equal to NFORX(I)
- KFORX(I)=positive number; panel edges are defined at KFORX(I) values of XJ defined in item 32

KFORX(I)=negative number; |NFORX(I)| equally spaced panel edges are defined within Ith segment

$$\sum_{I=1}^{NFUS} |KFORX(I)| \leq 51$$

The purpose of the last two K-option parameters on this card is to specify the options used to resolve the external body shape defined in items 16 through 25 into source panels. The user is allowed to either use the same geometry or modify the original coordinates in laying out the corners of the source panels. This alows the user to easily modify the panel layout without changing the original shape input. For the fuselage K0 should be set to zero, since no loads are computed.

For symmetric configurations (IXZSYM=0,1), KRADX is the number of meridians on the half-body including meridians at 0° and 180°. For full configurations (IXZSYM=-1), KRADX is the number of meridians on the full body including the meridians at 0° and 360°. However, for IXZSYM=1, after generating the panel geometry, KRADX(I) is redefined equal to the number of merdians on the full section for internal program use. The sum of KFORX(I), I=1,NFUS, must be less than or equal to 51. The number of panels in the circumferential and axial directions in each segment is thus one less than KRADX(I) and KFORX(I), respectively. For the fuselage KRADX(I) should be seven or greater for practical results. In selecting the axial spacing keep the ring thickness ratio (Δx/diameter) less than 1.0 for the fuselage.

This card is designated the KCARD in the data deck in columns 73-80.

Items 28 and 29 define the inlet and are included for NINLET+NINBLK+NINVEL greater than zero. Item 28 defines the number of traverses to be used to generate the inlet shock shape and defines the panel numbers designated as inlet panels or to be used in the inlet velocity calculations.

Item 28:

NIS — number of inlet shock shape traverses to be computed in INLSHK; $1 \leq \text{NIS} \leq 80/\text{MAXSHK}$ where MAXSHK was input in item 14

JINLT(I) — panel number of Ith open inlet panel, blocked inlet panel, or additional panel used in inlet velocity calculation. First NINLET values define the open inlet panels; the next NINBLK panel numbers define the blocked inlet panels and last, the next NINVEL panel numbers specify the additional panels which are used in inlet velocity calculations. I=1,IMAX where $\text{IMAX}=\text{NINLET}+\text{NINBLK}+\text{NINVEL} \leq 25$.

The JINLT(I) panel numbers must be compatible with the source panel numbers generated by the program. These numbers can be determined by running the program with NINLET=NINBLK=NINVEL=0 and examining the output obtained by setting IPRT(2)=1 in item 14.

Item 29 defines the β to be associated with the inlet panel special properties.

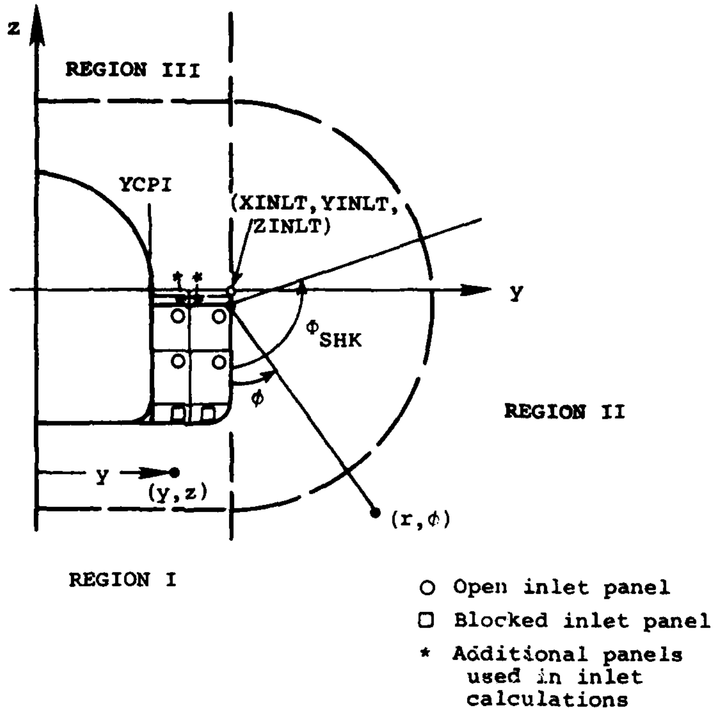
BTINLT — maximum β associated with inlet panel solution

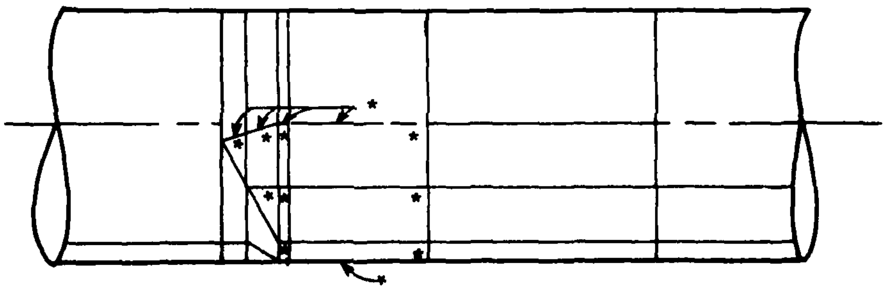
The user is required to lay out three types of panels in the vicinity of the inlet for use in the program. Each of these panels have special properties ascribed to them during the execution of the program. The inlet panels as defined here are those placed in the open face of the fuselage inlet. These panels are further subdivided into open and blocked inlet panels in accordance with the intake mass flow ratio (MFR). The first, the open inlet panels, are placed to model the unimpeded flow into the intake and enforce the condition that the flow must be equal to the free-stream velocity. The second, the blocked inlet panels, are placed to model that portion of the mass flow (MFR<1) which is spilled, or blocked from entering the inlet. Both panels

propagate their linear theory influence with β = BTINLT. This is required to keep the panel surface aft of the panel Mach cone in order to keep the solution numerically tractable. The ratio of open panel frontal area to the total of open and blocked frontal area defines the mass flow ratio (MFR) into the intake. It is the responsibility of the user when paneling the inlet to ensure that the physical layout of open and blocked panels match the desired inlet mass flow ratio for the engine and flight conditions at hand.

The third type of panels required in the vicinity of the inlet are the additional panels on the inlet cowl adjacent to and aft of the intake. These panels are only required in order to define the subset of the total configuration to be used in the generation of the inlet shock shape. Together with the panels covering the face of the intake, these additional panels form the set of panels used to compute the location of the shock emanating from the inlet. During this calculation they are assigned the property that β = BTINLT. For the remaining computations, their influence is propagated at β_∞. The minimum set of panels should include all panels on the cowl aft of the intake face extending past the inlet one ring of panels. The quantities defined here are used to lay out and assign the special properties to the inlet panels in the generation of the nonlinear shock shape associated with the oblique shock ramp type inlet shown on the next page.

The first value in item 28, NIS, determines the number and therefore the location of the traverses defining the shock. The traverses are positioned in a sequence predetermined by the number NIS as follows. The first traverse is positioned at y=YINLT and ϕ=0°. This determines the shock shape in the y=YINLT plane. The remaining traverses are computed alternately in regions I and II. The second traverse propagates from y=YINLT at ϕ=PHISHK. The third propagates from y=0 at ϕ=0°. The fourth is at y=YINLT and





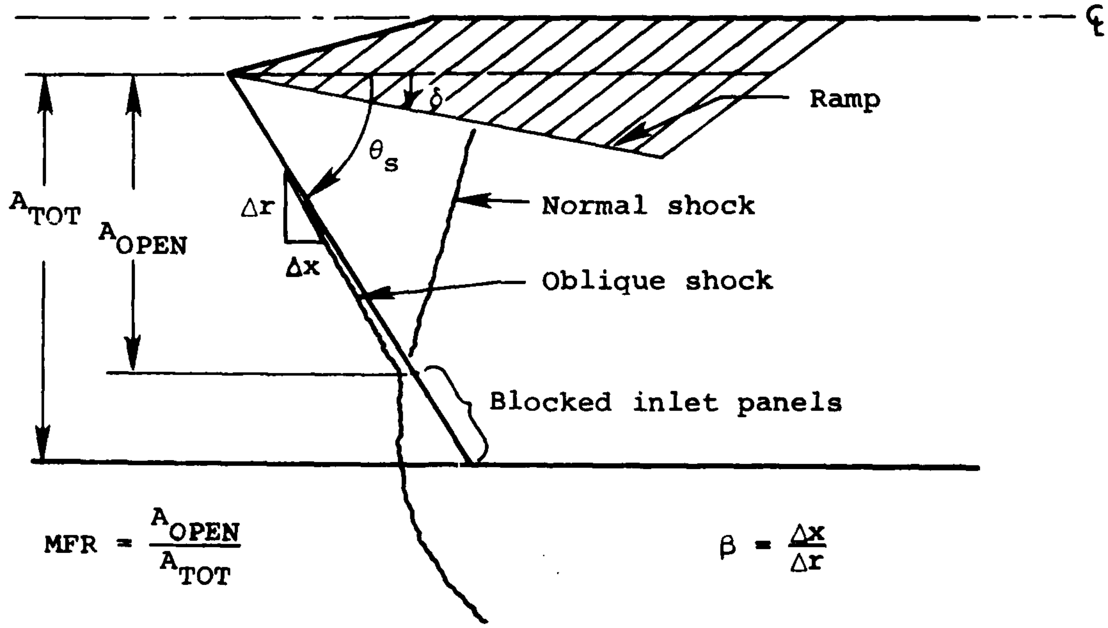
ϕ=PHISHK/2 and the fifth is at y=YCPI and ϕ=0°. Additional traverses are laid out by subdividing regions I and II alternately with even increments. The value of PHISHK is currently internally set to 90° to approximate the entire region under the wing of an aircraft with the wing tangent to the top of the inlet.

The inlet panel sequence numbers to be defined here are those indicated in the listing of the panel geometry. The panel numbers in the first NINLET values in the JINLT array are the numbers of the open inlet panels placed in the intake face through which air

may flow. The next NINBLK values in the JINLT array are the numbers of the blocked inlet panels placed on the intake face which have been positioned according to the engine mass flow ration to block the flow. The third set of panel numbers in the JINLT array are the additional panels covering the inlet cowling immediately aft of the inlet face that are necessary for use in the inlet velocity calculation. A typical set is indicated in the preceeding sketch. They are used to maintain the continuity of the linear theory velocity calculations immediately aft of the inlet during the determination of the shape of the nonlinear shock emanating from the inlet.

The maximum β(BTINLT) to be used for the inlet panels is determined as a function of M_∞ and the 2-D inlet ramp angle, δ, or deflection angle, from Chart 2 of Reference 9. The β is computed from the shock turning angle θ_s as BTINLT$\approx\tan(90°-\theta_s)$ as shown in the following sketch. This slope must be selected such that it does not exceed the slope of the panels on the inlet face. BTINLT should typically be 2-3% less than (ahead of) the corresponding slope of the inlet face.

Inlet Side View



For additional details on the use of the above parameters and the methods implemented in the program to model the inlet see Sections 3.2.3 and 4.2 of Reference 1.

Item 30 defines the reference lengths and areas used in the force and moment coefficient definitions. This item is omitted for the fuselage since K0 in item 27 should be input as zero.

REFAR	reference area, square feet. If greater than zero, redefines REFA in item 17
REFD	reference length or diameter used to nondimensionalize moments, feet. If blank, program sets value equal to 1.0
REFL	body length, feet. If blank, program sets value equal to XFUS(NFORX(NFUS))-XFUS(1)
REFX	x_B'-location of moment center, feet; see Figure 6
REFZ	z_B'-location of moment center, feet; see Figure 6

Item 31 defines the meridian angles for the edges of panels as optionally requested by KRADX(J) for each body segment. This item is included only if KRADX(J) is negative.

PHIK(I,J)	meridian angle of panel edges expressed in degrees; I=1,|KRADX(J)|,J=1,KFUS

The convention is observed that PHIK=0° is at the bottom of the body and PHIK=180° is at the top of the body. The value of PHIK(1,J)=0.0° and that of PHIK(|KRADX(J)|,J)=180° or 360° depending on the value of IXZSYM input in item 14. This option should be used to ensure that panel edges in the presence of a wing match exactly the meridian angle at the wing-body junction. Repeat this item for each fuselage segment. This card is designated PHIK in columns 73-80.

Item 32 defines the axial stations for the edges of panels. This item is included only if KFORX(J) > 0.

XJ(I,J) x-stations along fuselage defining panel leading and trailing edges for the Jth body segment, feet

These values are used to define the body leading and trailing edges of adjacent rings of panels. When selecting values in the vicinity of the body interference panels, values of XJ should be specified which correspond exactly to the leading and trailing edge of the interference shell. This card is repeated for each body segment and is designated XJ in columns 73-80.

Item 33 defines the location of the traverses which form the table describing the modified nose shock wave shape. These are input only for NSHOCK < 0 in item 14.

PHIS(I) specified angles at which integration or modified shock wave shape is calculated, degrees

The convention is used such that PHIS(1) is zero at the centerline on the bottom, and increases counterclockwise. PHIS(NSHOCK) only needs to span the region in which the store may travel. Only values which highlight nonlinearities in the R_{shock} versus ϕ need be defined. If NSHOCK > 0, the program generates values from 0° to the angle formed by a radial line through the wing tip, PHISHK. The angle PHISHK is internally defined as $\phi_{SHK} = 90°$.

Items 34 through 42 are used in the definition of the wing and body interference u-velocity panels and the wing thickness panels.

Item 34 contains three parameters which specify the wing location relative to the fuselage nose and the wing incidence

angle. The three parameters are shown pictorially in Figure 5.

XBWOC x_B location of intersection of wing leading edge with fuselage, feet; negative as shown in Figure 5

ZBWO z_B location of intersection of wing leading edge with fuselage, feet; negative as shown in Figure 5

WIC wing incidence angle relative to fuselage longitudinal axis, degrees; positive as shown in Figure 5

<u>Item 35</u> contains

CRW wing root chord

SSPAN wing semispan, feet

The definitions are shown in Figure 7(a). The wing root chord is the wing chord at the spanwise station, Y(1), at which the wing leading edge intersects the fuselage. Both quantities are input as positive quantities.

Items 36 and 37 are input data describing the left wing panel which are used to lay out the constant u-velocity panels. The quantities are

<u>Item 36</u>:

NCW number of u-velocity panels in a chordwise row on wing; NCW $\geq$ 4

MSW number of u-velocity panels in a spanwise row on wing; MSW $\leq$ 19

<u>Item 37</u>

I wing u-velocity panel side-edge number; I = 1 to MSW+1

Y(I) y_w location of Ith side edge on the left wing panel, feet (I=1 value shown in Figure 7(a); negative for all I's since on the left wing panel; measured in wing planform plane)

PSIWLE(I) leading-edge sweep of wing section to the right of the Ith side edge, degrees; positive swept back (measured in wing planform plane). PSIWLE(1)=0.0

PSIWTE(I) trailing-edge sweep of wing section to the right of the Ith side edge, degrees; positive swept back (measured in wing planform plane). PSIWTE(1)=0.0

PHID(I) dihedral angle of wing section to the right of the Ith trailing leg, degrees; positive up. PHID(1)=0.0

Based on these input data, the wing is divided chordwise and spanwise into trapezoidal shaped constant u-velocity panels. All the NCW panels in a chordwise row have equal side edge chords and spans, the spans being determined by the Y(I)'s.

The question arises as to the values to use for NCW and MSW. No specific rules can be given since the number needed is determined to some extent by the wing planform shape and the location of the store being separated. Fewer panels can be used on the wing if the store is under the fuselage than if the store is under the wing. The number of panels in a chordwise row, NCW, is also determined to some extent by the camber distribution, if any, since the camber, item 39, is specified at the panel control points. If the wing is uncambered except near the leading edge then a fairly large number of panels is required in a chordwise row if this effect is to be included. In general, a minimum of eight panels, NCW = 8, should be used.

The number of panels in a spanwise row, MSW, is controlled to some extent by the wing. A panel side edge must coincide

with the root chord and each break in leading-edge sweep angle, trailing-edge sweep angle and dihedral angle, and if a pylon is present, a trailing leg must coincide with the spanwise location of the pylon. One must also coincide with the wing tip. Consider the example wing alone in Figure 7(b). There is a break in trailing-edge sweep at $y_w/s = -0.2$, a break in leading-edge sweep at -0.4, a pylon at -0.6, and breaks in dihedral at -0.6 and -0.8. To place a panel side edge at each of these positions plus the wing tip and the root chord requires five panels across the semispan. This is the minimum number which can be used for this wing and is probably not sufficient. Experience with the program has shown that in some cases for simple wings six panels in a spanwise row have given good results.

The only sure way of determining convergence with number of panels, both NCW and MSW, is to examine the results obtained from the trajectory program. For a particular wing various panel layouts should be tried to assure convergence. The minimum number of panels, consistent with the desired accuracy, should be used in order to minimize the trajectory calculation time.

The maximum number of panels that can be placed on the left wing panel, pylon, and fuselage, is 200. This limit is imposed by dimension statements in the computer program. Thus, limits may be imposed on NCW and MSW in order to satisfy Equations (3), (4), and (5). These equations are presented in the discussion of items 9 and 10.

Item number 37 consists of a deck of MSW+1 cards. The index I is the panel side-edge number. The side edges are numbered from the root chord, I=1, to the tip, I=MSW+1. Associated with each I are the spanwise location of the side edge, Y(I), the sweep angles of the leading and trailing edges of the wing segment to the right of the side edge, PSIWLE(I) and

PSIWTE(I), and the dihedral angle of the section to the right, PHID(I). When I=1 these angles are input as zero.

The two indices of item number 38 are associated with the wing twist and camber distribution.

Item 38:

NTAC — twist and/or camber?
NTAC=0, no
NTAC=1, yes

NUNI — if wing has no twist, and the camber distribution is similar at all spanwise stations, NUNI=1; for all other cases, NUNI=0 (omit if NTAC=0)

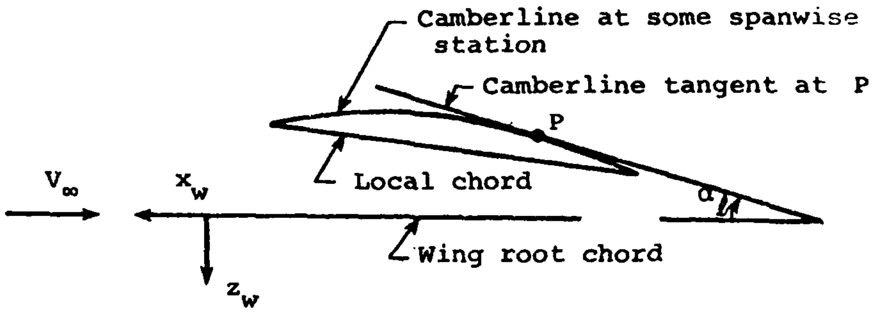
If NTAC=1, item number 39 is included in the input data deck. These data specify the wing twist and/or camber distribution in terms of the tangent of the local angle of attack of the camberline for a wing root chord angle of attack of zero degrees. The function of the index NUNI is explained below.

Item 39:

ALPHAL(J) — tan α_{ℓ} of the wing camberline at the constant u-velocity panel control points. If NUNI-1, only data for the chordwise row adjacent to the root chord are input. The first value is for the control point nearest the leading edge. If NUNI=0, data for all chordwise rows must be input starting nearest the root chord and working outboard. Data for each row start on a new card (omit if NTAC=0)

The constant u-velocity panel control points are at 95 percent of the chord which passes through the centroid of area (see Figure 5, Reference 1) of each elemental panel laid out by NCW, MSW, and Y(I)'s of items 36 and 37.

The values of ALPHAL(J) are obtained as follows. Consider the following sketch which shows the cambered and twisted section



of the lifting surface at some spanwise station for zero wing angle of attack. At the control point P, a tangent to the camberline is constructed, which makes an angle α_ℓ with the root chord (the x_w axis). The positive sense of α_ℓ is shown. The input value required is ALPHAL(J) = tan α_ℓ. For wings which have *the same camber* distribution at all spanwise stations and no twist, NUNI=1, data are only input for the row of control points closest to the root chord. The program assigns these values to all other rows.

The three indices of item number 40 are associated with the specification of the wing thickness distribution. They are

<u>Item 40</u>:

NCWS — number of thickness panels in a chordwise row on the wing

MSWS — number of thickness panels in a spanwise row on the wing; MSWS $\leq$ 19

NUNIS — if wing has a similar thickness distribution at all spanwise stations, NUNIS=1; if not, NUNIS=0

The thickness panels are laid out on the wing independently from the u-velocity panels. Three constraints limit the choice of the number of panels used. First, a total of 400 thickness panels can be used on the wing and pylon;

$$MSWS*NCWS + MSPS*NCPS \leq 400 \tag{7}$$

Similar to the wing, the technique of consolidation of strengths at panel corners imposes the two additional limits based on dimensions as follows

$$MSWS + k_w + MSPS + k_p + 2 \leq 60 \tag{8}$$

and

$$(MSWS+k_w+1)(NCWS+1) + (MSPS+k_p+1)(NCPS+1) \leq 1000 \tag{9}$$

where k_w is the number of breaks in sweep and dihedral on the wing and k_p is the number of breaks in sweep on the pylon. The number of spanwise panels required is a function of the spanwise variation of the thickness distribution and the number of breaks in sweep or dihedral. If the distribution of t/c with x/ℓ is constant in the spanwise direction (NUNIS=1) and there are no breaks in sweep or dihedral, only one row of panels is required. If the thickness is not similar and there are breaks in sweep and/or dihedral, more spanwise panel rows should be used as necessary. Each of these chordwise strips is divided into NCWS equal chord panels. Usually more thickness panels should be used in a chordwise row than u-velocity panels. Experience with the program has shown 12 to 14 thickness panels usually to be sufficient. Again, this can only be checked by varying the number and examining the resulting store load distributions. The minimum, consistent with the desired accuracy, should be used to minimize the trajectory calculation time.

Item 41 defines the wing planform information for the thickness panel layout in a manner similar to that in item 37. The variables are

Item 41:

I	wing thickness panel side-edge number; I=1 to MSWS+1
YS(I)	y_w location of Ith side edge on the left wing panel, feet (I=1 values same as for item 37 shown in Figure 7(a), negative for all I's since on left wing panel; measured in wing planform plane)
PSWSLE(I)	leading-edge sweep of wing section of thickness panels to the right of the Ith side edge, degrees. Positive swept back (measured in wing planform plane). PSWSLE(1)=0.0
PSWSTE(I)	trailing-edge sweep of wing section of thickness panels to the right of the Ith side edge, degrees. Positive swept back (measured in wing planform plane). PSWSTE(1)=0.0
PHIS(I)	dihedral angle of wing section of thickness panels to the right of the Ith trailing leg, degrees; positive up. PHIS(1)=0.0

This information is identical in form to that used to define the u-velocity panels on the wing. Though the identical information could be used for both layouts, it is recommended that more panels be used in the chordwise direction and only as many in the spanwise direction as required to account for breaks in sweep, dihedral, or changes in thickness distribution. A single strip of panels is acceptable when no such changes occur.

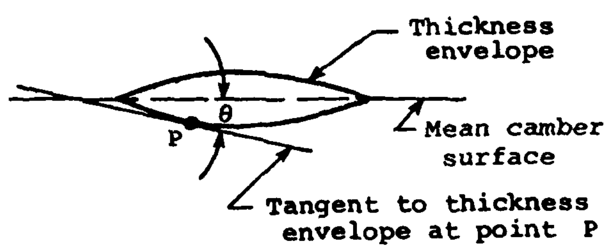
Item number 42 contains the thickness distribution.

Item 42:

THETAL(J) slope of the wing thickness distribution at the centroid of area of the thickness panels. If NUNIS=1 only data for the chordwise row adjacent to the root chord are input. The first value is for the panel at the leading edge. If NUNIS=0, data for all chordwise rows must be input starting at the root chord and working outboard. Data for each row start on a new card

Note that the values of the thickness slopes are input for the centroid of area of each panel. Also, for wings with similar distributions at all spanwise stations, NUNIS=1, data are only input for the row of panels adjacent to the root chord. The program assigns these values to all other rows.

The values of THETAL(J) are obtained as follows. Consider the following sketch which shows the thickness envelope at a



spanwise station where the slopes are to be determined. At a point P at which the slope is required, a tangent to the surface of the thickness envelope is constructed which makes an angle θ with the line connecting the leading and trailing edges of the envelope. The input value required is THETAL(J) = tan θ. Forward of the point of maximum thickness θ is positive and aft of this point it is negative. In some cases for a wing with a blunt leading edge, the thickness slope should not exceed a

certain value. The determination of this value is discussed in detail in Section 3.4.1 of Reference 2.

The next six items of input data, items 43 through 48, are associated with the pylon if one is present, NPY=1. If NPY=0 items 43 through 48 are omitted from the input deck. Both the u-velocity and thickness panels on the pylon follow the format and limitations prescribed for the wing panels. Item 43 consists of one card and contains the following quantities:

Item 43:

IP	index of the y_w location of the pylon. This must be one of the Y(I)'s read in for the wing, item 37, if under the wing. If the pylon is under the fuselage centerline, IP=0
CRP	length of pylon root chord, feet
HP	height of pylon measured from wing chordal plane, feet
XPLE	location of pylon root chord leading edge measured from local wing chord leading edge, feet (negative behind)

The pylon location can be under the fuselage, IP=0, or at one of the wing-panel side-edge locations outboard of the wing-fuselage juncture. The remaining variables are shown in Figure 8 for the two cases with only one spanwise panel on the pylon. Note from Figure 8 that for a pylon under the fuselage, XPLE is measured from the wing root chord leading edge and HP is measured from the bottom of the fuselage.

The next two items of input data are associated with the constant u-velocity panels which represent the pylon loading. Item number 44 is one card and contains:

Item 44:

NCP	number of panels in a chordwise row on the pylon
MSP	number of panels in a spanwise row on the pylon MSP $\leq$ 19

For a typical pylon, two or three panels in a spanwise row are sufficient, MSP=2 or 3. The number chordwise, NCP, depends on the length of the pylon root chord. The chordwise dimensions of the trapezoidal shaped area elements on the pylon should be approximately the same as those on the wing immediately above the pylon. That is, the local wing chord length divided by NCW of item 36 should be approximately equal to the pylon root chord length divided by NCP.

The program is limited to 200 constant u-velocity panels on the wing-pylon-fuselage combination. NCP and MSP must thus follow the restrictions imposed by program dimensions as specified in Equations (3), (4), and (5).

Item number 45 consists of a deck of MSP+1 cards which contain the following information.

Item 45:

K	pylon-panel side-edge number; K = 1 to MSP+1
Z(K)	z location of the Kth side edge, feet; measured from local wing chord
PSIPLE(K)	sweep angle of the pylon leading edge above the Kth side edge in the wing coordinate system, degrees. Positive sweep is swept back. PSIPLE(1)=0.0
PSIPTE(K)	sweep angle of the pylon trailing edge above the Kth side edge in the wing coordinate system, degrees. Positive sweep is swept back. PSIPTE(1)=0.0

The first side edge should be placed on the pylon root chord and the last on the tip chord. The remaining side edges are spaced between these two. For a pylon located under the fuselage, Figure 8(a), Z(1) should be the z_w location of the pylon root chord, the bottom of the fuselage, and Z(MSP+1) should equal Z(1) + HP. For a pylon under the wing, Z(1) = 0 and Z(MSP+1) = HP.

Items 46, 47, and 48 provide data required to model the pylon thickness distribution. These items follow the same format, basic descriptions, and limitations imposed on the wing thickness panels in items 40 through 42 with the exception that no provision is made for dihedral effects.

Item 46:

NCPS	number of thickness panels in a chordwise row on the pylon
MSPS	number of thickness panels in a spanwise row on the pylon; MSPS $\leq$ 10
NUNIP	if pylon has a similar thickness distribution at all spanwise stations and there are no breaks in sweep, NUNIP=1, if not, NUNIP=0

Item 47 consists of a deck of MSPS+1 cards which contain the following information.

Item 47:

K	pylon thickness panel side-edge number; K=1 to MSPS+1
ZS(K)	z location of the Kth thickness panel side edge, feet; measured from local wing chord

PSPSLE(K) sweep angle of the pylon leading edge above the Kth thickness panel side edge in the wing coordinate system, degrees. Positive sweep is swept back. PSPSLE(1)=0.0.

PSPSTE(K) sweep angle of the pylon trailing edge above the Kth thickness panel side edge in the wing coordinate system, degrees. Positive sweep is swept back. PSPSTE(1)=0.0

The placement of the panel side edges follows the same rules as for locating the u-velocity panels. Panel edges are required at all breaks in sweep and changes in thickness distribution.

Item 48 defines the thickness envelope of the pylon in the same manner shown for the wing in item 42 as follows.

Item 48:

THETPL(J) slope of the pylon thickness distribution at the centroids of the thickness panels. If NUNIP=1 only data for the chordwise row adjacent to the root chord are input. The first value is for the panel at the leading edge. If NUNIP=0, data for all chordwise rows must be input starting at the root chord and working outboard. Data for each row start on a new card.

These data are prepared in the same manner as were the corresponding data for the wing thickness, item 42. Comments made there concerning a blunt leading edge also apply to the pylon.

Choice of the number of thickness panels on the pylon is still limited by the number of panels on the wing-pylon combination and should always be kept at the minimum consistent with

the accuracy of the results. NCPS and MSPS must thus follow the restrictions imposed by the program dimensions as specified in Equations (7), (8), and (9).

The next five items of input data locate and describe the ejection rack if one is present (NRACK of item 4 is equal to one). If NRACK=0, these five items are omitted. If a rack is present the preceding data for the pylon must have been input since the program has been written assuming that if there is a rack there is also a pylon. The rack data to be input only model the body of the rack.

Item 49 is one card and locates and sizes the rack from the following information.

Item 49:

RLTHC	length of rack, feet
RRMAX	maximum rack radius, feet
XRNC	x_ℓ location of rack nose measured from local wing chord leading edge, feet; positive ahead. The x_ℓ, z_ℓ coordinate system is shown in Figure 8
ZRN	z_ℓ location of rack nose measured from local wing chord leading edge, feet; positive below. The x_ℓ, z_ℓ coordinate system is shown in Figure 8
RIC	rack incidence angle measured relative to wing root chord, degrees; positive nose up

Item numbers 50, 51, and 52 define the shape of an equivalent circular body used to model the rack.

Item 50:

NRPOLY	number of polynomials specifying the circular rack shape; $1 \leq \text{NRPOLY} \leq 7$

Item 51:

RXEND(J) X/ℓ of end points of polynomials specifying rack shape, NRPOLY values

Item 52:

RCOEF(J,K) coefficients of polynomials specifying shape

These data specify the radius distribution of the equivalent circular body rack and are used in the calculation of the source-sink distribution which represents the rack volume and the doublet distribution which represents the rack angle of attack effects. The polynomials, given by Equation (1), follow the same rules and definitions as used to define the circular body fuselage in items 6 through 8.

Item 53 is one card and contains the following:

Item 53:

NRSOR number of rack sources; NRSOR $\leq$ 100

RTHSHK maximum shock wave angle at nose, degrees

The number of sources, NRSOR, follows the same general rules used to specify the source distribution of the fuselage in item 9. The angle, RTHSHK, is used as the limiting value at nose in generating the modified shock wave shape. It is obtained from Reference 9, and follows the same rules used to define FTHSHK for the fuselage in item 11.

If no store is present (NSTRS of item 4 is equal to zero) this concludes the input data deck. If NSTRS is not zero, the remaining items in the data deck for Program I are used to describe each of up to seven circular or elliptic shaped stores. The information included here describes the stores in their carriage position. Information pertaining to the separated store will be included in Program II.

The number of stores present is defined in item 4. The stores are limited to two types, circular and elliptic. The circular store method employs the line source and doublet analysis as used for the circular fuselage. The method is the most efficient numerically, but is limited to the consideration of only one set of monoplane or cruciform fins in Program II. The elliptic store method uses the source paneling method of analysis. A circular store can also be modeled by this method. Though many routines used are common with the fuselage description for a noncircular body, a few subroutines still exist restricting this portion of the analysis to consideration of only elliptic store body shapes. This store option also must be used when considering multiple sets of wing or fin combinations.

Item 54 consists of NSTRS cards, one for each store, containing the following information for J=1 to NSTRS.

Item 54:

NUMSTR(J)	store number; $\leq$ 99
NSHAPE(J)	shape number of store. If NSHAPE(J)$\leq$50, circular store body option is used; if 51$\leq$NSHAPE(J)$\leq$99, elliptic store body option is used
SLTHC(J)	length of store, feet
SRMAX(J)	maximum radius of store feet; SRMAX=0.0 for elliptic store option
XSNC(J)	x_ℓ location of store nose measured from wing chord leading edge immediately above store, feet; positive ahead
YSN(J)	y_w location of store nose measured from fuselage centerline, feet; positive to the right
ZSN(J)	z_ℓ location of store nose measured from wing chord leading edge immediately above store, feet; positive below

SIC(J) store incidence angle measured relative to wing root chord, degrees; positive nose up

SPHIR(J) roll angle of store body coordinate system relative to inertial or fuselage coordinates, degrees; positive right wing down viewed from the rear

The shape number is used to distinguish between circular and elliptic analysis options. Shape numbers greater than 50 are arbitrarily reserved to designate stores to be modeled using the elliptic store option. A total of seven stores and seven shapes may be used. Only two of those shapes may be elliptic, though multiple stores of those shapes may exist. The above coordinates and orientations define the locations of the stores in their carriage positions. For the ejected store in Program II, the initial values for angles Θ and Φ are set to SIC and SPHIR. The roll orientation of the store coordinates should typically be zero for circular body option. It may be nonzero for the elliptic option where alignment of the store coordinates with the particular carriage position is required.

To avoid redundant input data associated with multiple stores with the same shape, the remaining store data is included only once for each shape appearing in item 54. Item number 55 is one card which contains:

<u>Item 55</u>:

NSHPT number of different values of NSHAPE(J) from item number 54; $1 \leq$ NSHPT ≤ 7. Only two shapes may have NSHAPE(J) greater than 50

One data deck of items 56 through 76 follows for each of the NSHPT store shapes as dictated by NSHAPE(J), J=1,NSTRS. <u>For stores modeled using the circular store option, NSHAPE(J)$\leq$50, only items 56 through 59 are required. For stores modeled using the</u>

elliptic store option, $51 \leq NSHAPE(J) \leq 99$, items 56 and 60 through 76 are input as required.

Item number 56 is the first shape card and contains the following:

Item 56:

MSHAPE(J) — shape number of Jth store shape;
if $MSHAPE(J) \leq 50$, circular store option and data to be used;
if $\leq 51MSHAPE(J) \leq 99$, elliptic option and data to be used

MSOR — number of line sources and line doublets to be used to model the store volume and angle of attack effects; $MSOR \leq 100$. Value required only if $MSHAPE(J) \leq 50$

STHSHK — maximum nose shock wave angle, degrees

The variable MSOR is required only for the circular store option. A value of MSOR of 30 to 40 should be sufficient to model a circular store. The value can be varied to determine whether increasing the number affects the trajectory. The angle, STHSHK, is used as the limiting value at nose in generating the modified shock wave shape. It is obtained from Reference 9, and follows the same rules used to define FTHSHK for the fuselage in item 11. For elliptic configurations either an equivalent circular cone value should be used, or if better information is known, the limiting angles associated with each radial traverse should be included in item 76.

Item numbers 57, 58, and 59 specify the circular store shape and are required only for $MSHAPE(J) \leq 50$. They are, respectively:

Item 57:

NSPOLJ number of polynomials specifying store shape; $1 \leq NSPOLJ \leq 7$

Item 58:

SXNDJ(J) x/ℓ of end points of polynomials specifying store shape; NSPOLJ values

Item 59:

SCOFJ(J,K) coefficients of polynomials specifying shape

These data specify the radius distribution of the store and are used in the calculation of the source-sink distribution which represents the store volume and the doublet distribution which represents the store angle of attack effects. Up to seven polynomials may be used. The polynomial programmed is given by Equation (1). The polynomials must be input for a shape which is made dimensionless by the store length since the trajectory program is written assuming this to be the case.

Item number 57 specifies the number of polynomials. Item number 58 consists of one card which contains the NSPOLJ values of the end points of the polynomials describing the shape.

Item number 59 is a set of NSPOLJ cards specifying the values of the coefficients of the polynomials, Equation (1). All seven coefficients are input even though some of them may be zero.

For circular store shapes, this is the last item required for a given store shape.

Items 60 through 76 are included here to describe the store body geometry for each of the elliptic store shapes, MSHAPE(J)>50. These input items are defined similar to items 13 through 32 used to describe the fuselage. Some of the same input subroutines are

shared between the fuselage and the store. The generalizations to nonelliptic store configurations have not been made.

Item 60 consists of one card with the alphanumeric description for the elliptic store shape definition. In the remaining cards columns 73-80 in items 61 through 76 have been left open for user comments and will be used here to designate card names.

Item 61 defines some of the optional print and execution parameters associated with the source paneling analysis as follows.

Item 61:

IXZSYM — store XZ paneling symmetry option. For store using paneling option both sides of body must be paneled due to nonuniform flow field. For the store, input IXZSYM=1.

- IXZSYM=1, configuration is symmetric; panel both halves of body from data of first half
- IXZSYM=-1, configuration is asymmetric; data for both halves are input

IPRT — optional print control parameter

- IPRT(1)=0, do not print copy of input data
- IPRT(1)=1, print formatted copy of input data
- IPRT(2)=0, do not print supplementary geometry data
- IPRT(2)=1, print panel geometry, angles, and areas
- IPRT(3)=0, do not print modified shock wave shape
- IPRT(3)=1, print modified shock wave shape in BSHOCK
- IPRT(4)=0, not used
- IPRT(5)=0, do not print velocity and source strength output
- IPRT(5)=1, print source strengths and velocities used in boundary condition associated with each panel

IUVW component velocity influence coefficient calculation option. For the store shapes, input IUVW=0.
- IUVW=0, save coefficient arrays
- IUVW=1, do not save coefficient arrays

NSHOCK controls number and where modified shock wave shape traverses are made,
- NSHOCK=0, a single traverse is calculated at 0°, the bottom of the store; circular symmetry is assumed
- NSHOCK=positive, NSHOCK equally spaced shock traverses are computed between 0° and 90°
- NSHOCK=negative, NSHOCK traverses are computed at input values of PHIS(K), K=1,|NSHOCK| in item 76

MAXSHK maximum number of integration steps in radial direction used to generate nonlinear shock shape; $1 \leq \text{MAXSHK} \leq 100/\text{NSHOCK}$

NINLET number of open inlet panels (not applicable to stores); input NINLET=0

NINBLK number of blocked inlet panels (not applicable to stores); input NINBLK=0

NINVEL number of panels used in inlet velocity calculation (not applicable to stores); input NINVEL=0

The parameter IXZSYM is to allow the user to model the full body from the geometry of only the right hand side, or a full nonsymmetric configuration. Since the store is immersed in a nonuniform flow field, both halves must be paneled. The print controls, IPRT, are used to control output from each phase during execution. The output from the input phase is used to echo the data read. The geometry output includes the panel coordinates, control points, areas and inclination angles. The shock output includes the nose shock shape. The velocity print control is used only to examine the influence coefficient matrix. The last print

control displays the panel strength and boundary conditions. The parameter IUVW is used to suppress the storage of the component velocity coefficient arrays. These are only required during the calculation of panel pressures and loads. This information is required only for the force calculations on the separated store. Therefore the arrays need be saved only for the separated store shape.

The number of nose shock shape traverses, NSHOCK, allows the user to specify the traverses which best describe the nonlinear shape of the shock in the meridional direction or allow the program to specify an even spacing. For the elliptic store with NSHOCK=0 the nose shock shape is generated at $\phi = 0°$, the bottom of the store, and assumes both right-left and top-bottom symmetry. Meridional traverses are required between $\phi = 0°$ and 90° so NSHOCK should be positive. MAXSHK limits the number of points in each radial traverse to minimize computing time and also acts as the internal first dimension in the X and R arrays containing the shape. It should be sufficient to allow enough points to be computed to describe the shape. The number of searches NSHOCK*MAXSHK, used to define the shock shape is among the most time consuming operations.

The quantities NINLET, NINBLK, and NINVEL should always be zero.

The suggested values of the above parameters to use are IXZSYM=1, IPRT(1)=IPRT(2)=IPRT(3)=IPRT(5)=1, IPRT(4)=0, NSHOCK=4, and MAXSHK=10. The parameter IUVW should be set equal to zero for the separating store. It may be set to one for any shape not to be separated from the parent aircraft in Program II. The card is designated the IOPTS in columns 73-80.

Item 62 specifies several variables which locate the body interference shell and modified shock wave shape.

Item 62:

XBIP — x-station at which the Y,Z geometry used in the definition of the body interference shell is obtained; not used so should be input as zero or left blank

XSHLDR — x-station which is considered to be the "shoulder" of the body nose. If set equal to zero, the value is computed from the location of the first occurrence of a maximum in the cross-sectional area

EALPHA — angle of attack correction used in rotating the body shock wave shape emanated from the nose about the store by α_c(1-EALPHA)

Since the same input routine is being used for both the fuselage and stores, XBIP appears here. However, no value for XBIP is required for the stores in Program I, and XBIP should be input as zero or left blank. Section information for the interference shells on the separating store empennage(s) are generated from input in the second program. The specification of the shoulder x-location, XSHLDR, is only meant to provide a reasonable estimate of the point where the nose stops increasing in area. It is used to estimate the aft point where the modification of the shock wave shape returns to the original linear theory value. The parameter EALPHA defines the amount of deviation from a straight rigid rotation of the store nose shock wave about the nose. The angle from the axis of symmetry of the nose shock to the body centerline is thus defined as $\alpha_s = \alpha_c$(1-EALPHA). EALPHA is limited to values from 0.0 to 1.0 representing the range of rigid shock rotation to no shock rotation with angle of attack. The value of EALPHA for circular cones may be determined as a function of Mach number and nose semi-vertex angle from Table 14 in Reference 10. A plot of the data in Table 14 is also found in Figure 4 of this report. In lieu of better information for noncircular shapes use the vertex angle of an equivalent circular

cone. A value of EALPHA=0.0 is equivalent to the methods assumed by the circular store model. This card is designated XBIP in columns 73-80.

The next eight items, numbers 63 through 70, define the external shape of the elliptic store. They specify the store shape in as great a detail as the user desires. The subdivision of the store surface described here into discrete panels is performed in items 71 through 75.

Item 63 contains control integers used to specify the type and amount of the input used to define the store external geometry. The variables defined here and in the next seven items control the specification of the external body shape and not the panel layout as follows.

Item 63:

J0 — read reference area card; for stores input J0=0
- J0=0, do not read item 64
- J0=1, yes, read item 64

J2 — integer flag indicating type of data describing store body geometry for external shape.
- J2=-1, data for circular body in form of cross-sectional areas versus XFUS (item 65) to be entered; include section data in item 67
- J2=-2, data for circular body in form of radius versus XFUS (item 65) to be entered; include section data in item 68
- J2=-3, data for elliptic body to be entered in form of semi-axes in y- and z-directions; include items 68 and 69
- J2=-4, data for elliptic body to be entered in form of vertical semi-axis, A, and elliptic ratio, B/A; include items 69 and 70

J2=-5, data for elliptic body to be entered in form of horizontal semi-axis, B, and elliptic ratio, A/B; include items 68 and 70

J6 — integer indicating whether body centerline is cambered. For stores input J6=-1.
J6=0, body is cambered; if J2<0, include item 66
J6=-1, body is uncambered; omit item 66

NFUS — number of body segments; for store only one body segment is allowed, NFUS=1

NRADX — number of points used to specify cross section of the store. If the configuration is symmetric (IXZSYM=1) NRADX is input for the half section. If the entire configuration is input (IXZSYM=-1) NRADX is input for the full section. If the body is circular or elliptic, the program computes NRADX Y- and Z-ordinates about the entire section, NRADX $\leq$ 33

NFORX — number of axial stations on body at which external geometry is specified; NFORX < 51

The reference area read under J0=1 may also be read later for K0=1 in item 73. For the store to be separated, reference areas and lengths will be required. The K0 option should be used to input these items.

The quantities NRADX and NFORX specify the number of points in the meridional and axial direction to be input or computed to define the external store shape. The value of NRADX remains constant for all sections along the store. NRADX represents the number of pairs of Y and Z values calculated at each section. NRADX and NFORX should be greater than or equal to KRADX and KFORX defined later to avoid paneling that lies inside the actual external geometry shape. Long constant geometry sections need only be defined at the beginning and end. When used to define the actual panel layout they should follow the rules for KRADX

and KFORX in defining panels later. The choice of NFORX must further satisfy the constraint that it be less than 51. This card is designated JCARD in columns 73-80.

Item 64 contains the reference area of the store. It may be redefined by item 73. This item is not included if J0 in item 63 is input as J0=0. If not defined, REFA is set equal to 1.0. This card is designated REFA in columns 73-80.

The values in items 65 through 70 define the external shape of the store as dictated by the previous control variables. This complete set of items is included only once. All descriptions must be given in order of increasing values of x (nose to tail).

Items 65 and 66 specify the x- and z-values of each axial station defining the store as follows.

Item 65:

XFUS(I) axial station at which body cross section data is included, feet; I=1, NFORX

Item 66:

ZFUS(I) input only if J6=0 in item 63; z-value of camber offset, feet; I=1,NFORX

The values of XFUS define the axial stations at which subsequent section data is presented. The first value of XFUS (=0.0) must be at the body nose. All values must increase monotonically to the last value, XFUS(NFORX). These values are shown pictorially in Figure 6. ZFUS is used to specify curvature in the centerline of the body. The cards are designated the XFUS and ZFUS cards in columns 73-80.

For J2 less than zero, user requested combinations of items 67 through 70 are used to define the values of standard sections as follows (I=1,NFORX).

Item 67:

FUSARD(I) for J2=-1, cross-sectional area of circular body, square feet; omit this item for other values of J2

Item 68:

FUSBY(I) for J2=-2, radius of circular body, feet; for J2=-3 or -5, length of horizontal semi-axis, B, of an ellipse, feet; omit this item if J2=-1 or -4

Item 69:

FUSAZ(I) for J2=-3 or -4 length of vertical semi-axis, A, of an ellipse, feet; omit this item for other values of J2

Item 70:

ERATIO(I) for J2=-4, elliptic ratio B/A; for J2-5, elliptic ratio A/B; omit this item for other values of J2

These combinations of variables define the possibilities of specifying the circular and elliptic shapes at each axial station. When defining an elliptic shape (J2=-4 or -5) using one of the semi-axes and the elliptic ratio, only the first value has to be defined. All subsequent values equal to zero (not defined) are set equal to the previous value. A value or a blank must be set aside for each value, with any number of changes in elliptic ratio in between. These cards are designated FUSARD, FUSBY, FUSAZ, or A/B in columns 73-80, respectively.

Item 71 contains any desired identifying information relating to the paneling sequence from the previous external geometry shape.

Item 72 defines the control variables used to specify the revision of the configuration into panels. This card is similar to item 63 with the difference that it defines the layout of the source panels themselves as follows.

Item 72:

KO read reference area and length card;

KO=0, no card included

KO=1, yes, include item 73

for the store to be separated, input KO=1

KRADX number of meridian lines used to define panel edges. There are three options for specifying the number of panel edges, $-33 \le KRADX \le 33$

KRADX=0, the number of meridians is set equal to NRADX

KRADX=positive, the meridian lines are calculated at KRADX equally spaced angles about the body

KRADX=negative, the locations of meridian lines are input at specified values of PHIK in item 74

KFORX number of axial stations used to define leading and trailing edges of panels. Three options are available

KFORX=0, the number of axial stations is set equal to NFORX

KFORX=positive, panel edges are defined at KFORX values of XJ defined in item 75

KFORX=negative, NFORX equally spaced panel edges are defined

The purpose of the three K-option parameters on this card is to specify the options used to revise the external body shape defined in items 63 through 70. This allows the user to easily modify the panel layout without changing the original shape input. For the store to be ejected the reference area and length card must be read (KO=1). These dimensions are passed to Program II and are the values used in normalizing all store load calculations.

For symmetric configurations (IXZSYM=1), KRADX is the number of meridians on the half-section. For full configurations (IXZSYM=-1), KRADX is the number of meridians on the full section including the meridians at 0° and 360°. However, for IXZSYM=1 after generating the panel geometry KRADX is redefined equal to the number of meridians on the full section for internal program use. The value of KFORX for the store must be less than or equal to 51. The number of panels in the circumferential and axial directions in each segment is thus one less than KRADX and KFORX, respectively. For elliptic stores KRADX should be five or greater on a half body for practical results. In choosing the number of axial stations for a store body the resolution of the load distribution axially must be of concern. If the store is in the free stream or is not to be separated, a ring length to diameter ratio as high as one should be sufficient. If the store is in the presence of shocks propagating from other bodies including its own reflected shock, the axial spacing should be sufficiently small to resolve the pressure spike of the shock with at least two to three rings of panels, considering both the "smearing" of the shock pressure rise and the inclination of the shock to the body. This ultimately should be arrived at by convergence of the load distribution. The total number of panels used around the body interference shell, NBDCR, is also derived from KRADX as: NBDCR=KRADX-1. The program is thus restricted to a maximum number of source panels NBODY=(KRADX-1)(KFORX-1)$\leq$1600 and indirectly by the number of panels on the interference shell NBDCR*NCWB$\leq$100 in the second program. This card is designated the KCRAD in the data deck in columns 73-80.

Item 73 defines the reference lengths and areas used in force and moment coefficient definitions. Omit this item if K0 in item 72 is K0=0.

<u>Item 73</u>:

REFAR	reference area, square feet. If greater than zero, redefines REFA in item 64

REFD reference length or diameter used to nondimensionalize, feet. If blank, set equal to 1.0

REFL body length, feet. If blank, set equal to XFUS(NFORX)-XFUS(1)

REFX x_B' -location of moment center, feet; see Figure 6

REFZ z_B' -location of moment center, feet; see Figure 6; input REFZ=0.0

Item 74 defines the meridian angles for the edges of panels as optionally requested by KRADX. Omit this item if KRADX$\geq$0 in item 72.

Item 74:

PHIK(I) meridian angle of panel edges expressed in degrees. Included only if KRADX is negative; I=1,|KRADX|

The convention is observed that PHIK=0° is at the bottom of the body and PHIK=180° is at the top of the body. This option should be used to ensure that panel edges in the presence of fins on either of two sets of empennages match exactly the meridian angle at the fin-body junction(s). These angles are also used in Program II to lay out the empennage body interference panels. This card is designated PHIK in columns 73-80.

Item 75 defines the axial stations for the edges of panels as follows. Omit this item if KFORX$\leq$0 in item 72.

Item 75:

XJ(I) x-stations along body defining panel edge between rings, feet; I=1,KFORX

These values are used to define both the leading and trailing edges of adjacent rings of panels. If KFORX is zero, these stations are set equal to XFUS in item 65. When selecting values

in the vicinity of the body interference panels, the XJ should be specified which corresponds exactly to the leading and trailing edge of the empennage-body interference shell. This card is designated XJ in columns 73-80.

Item 76 defines the location of the traverses which form the table describing the modified shock wave shape. This item is omitted if NSHOCK$\geq$0 in item 61.

PHIS(I) specified angles at which integration of modified shock wave shape is calculated, degrees; I=1,|NSHOCK|

The convention is used such that PHIS(1) is zero at the centerline on the bottom, and increases counterclockwise viewed from the rear. For those stores which are not separated, PHIS(NSHOCK) need only span the region in which the separated store may travel. For the store to be separated, the PHIS values can be specified from 0 to 90 degrees, which by symmetry will provide a description of its shock throughout 360 degrees. If NSHOCK > 0, the program generates values from 0° to the angle formed by a radial line through the wing tip. Only values which highlight nonlinearities in the R_{shock} versus ϕ need be defined. For the store all modified shocks are calculated at zero degree angle of attack and with PHIS(NSHOCK)=90°. The resulting table interpolation assumes symmetry in the shock wave shape in both the XY- and XZ-planes.

3.2.3 Sample input data

A sample input data deck will now be presented. It will utilize the wind tunnel model components shown in Figure 9 except that they have been scaled up by a factor of 20 and converted from inches to feet in order to approximate a full-scale aircraft and store. The models were used in the wind tunnel test program described in Reference 11.

The configuration for the sample calculation is shown in Figure 10. It consists of a noncircular wing-fuselage-inlet combination of Figure 9(a), the pylon of Figure 9(d), and the elliptic store of Figure 9(e). The store is shown in its initial position at the carriage position on the pylon.

The input data deck is tabulated in Figure 11. The item numbers indicated on the figure correspond to those of Figure 2. The first item on Figure 11 is item number 1 which contains the value of NCARDS, in this case 8. This is followed by item number 2, which consists of these 8 cards of identifying information.

Item number 3 specifies the aircraft flight conditions. Only the angle of attack and Mach number of the parent configuration are required in the first program. The angle of attack is 5.0° and the Mach number is 1.5.

The aircraft components which are present are specified by item 4. There is a noncircular fuselage, NFU=2; there is a pylon, NPY=1; and there is one elliptic store, NSTRS=1.

Items 11 through 32 define the noncircular fuselage input data. Item 11 contains the fuselage length, maximum fuselage radius, maximum nose shock angle, and body interference shell length. Item 12 contains the number of rings of u-velocity panels on the interference shell. The remaining items, 13 through 32, define the fuselage external geometry and source panel layout. The body length, maximum radius, and interference shell length are shown in Figure 10. The maximum nose shock angle is determined from Chart 5 of Reference 9 for a nose cone semivertex angle of 16°. Since the wing trailing edge is supersonic and since no rearward motion of the store is expected,

BODYPL is input as the length of the wing root chord as shown in Figure 10. Nine rings of panels are placed on the interference shell, NCWB=9, to correspond to the number of rows of panels on the wing chord. The number and spacing of panels around the circumference is set identical to the Y,Z values computed at station XBIP indicated in item 15.

Item 13 through 21 define the external shape of the fuselage using the arbitrary cross section option. Item 13 is the descriptive title for the fuselage model configuration. Item 14 defines optional print and execution parameters controlling the source panel calculations. The fuselage layout is defined symmetric, IXZSYM=0; the print parameters IPRT(1)=1, IPRT(2)=1, IPRT(3)=1, IPRT(4)=0, and IPRT(5)=1 control the printing of input data, panel geometries, nose and inlet shock shapes, and panel strengths and supression of print of velocity coefficient calculations. The parameter IUVW=1 suppresses the writing of source panel influence coefficient arrays onto TAPE12. The parameter NSHOCK=3 generates equally spaced traverses defining the nonlinear nose shock shapes at PHIS=0^{o}, 45^{o}, and 90^{o}. MAXSHK=8 limits the number of radial steps in the shock traverses to eight. The inlet parameters, NINLET, NINBLK, and NINVEL, identify that there are 4 open inlet panels, 2 blocked inlet panels and 19 additional panels to be used in the velocity calculations used in the definitions of the inlet shock shape. This panel layout on the inlets is specified in order to match an inlet mass flow ratio of 0.87.

Item 15, the XBIP card, defines the axial station at which the body interference shell cross section is defined, the x-location of the fuselage shoulder and the shock angle of attack correction. The interference shell geometry is generated at XBIP=28.0 as shown in Figure 10. XSHLDR is set equal to zero to allow the program to compute the value from the first nonexpanding

area location. The value EALPHA=0.315 is obtained from Figure 4 for a semivertex cone angle, σ, of 16° and Mach number of 1.5.

Item 16, the JCARD, defines the form and number of external geometry values to be read for the noncircular configuration. J0=0 indicates that no reference area (item 17) will be read. J2=1 specifies that the arbitrary Y-Z cross section option will be used to define the body shape. Any chamber in the body will be handled through the YZ input so J6=-1. NFUS=5 identifies that there will be five body segments used to define the geometry. The five pairs of KRADX(I) and KFORX(I) define the number of meridional and axial stations to be input for each body segment.

Items 18, 20, and 21 are the axial stations of the body cross sections, and the Y and Z coordinates of the meridional points defining the fuselage external shape. Item 18, the XFUS cards, specify the 19 axial stations in the first segment at which Y-Z pairs are input. They are followed by 19 pairs of Y,Z cards with 10 values of Y or Z per card. They are identified by Y-N3B2WA4, Z-N3B2WA4 for the wind tunnel model configuration used. The next three repetitions of items 18, 20, and 21 define the cross sections at the inlet, while the last set defines the fuselage aft of the inlet. The values of Y and Z are computed from the values of R and X in Figure 9(b) at each of the fuselage stations. The cross-sectional shape is subdivided to get a total number of nine panels on the half body: two on the bottom straight, one on the lower rounded corner, two on the vertical side, and four on the circular arc on the top. If KRADX(I) and KFORX(I) in item 27 are set to zero, the input values of Y and Z will become panel corners. The sets of values for the inlet are input at the exact corners to be used for the inlet panels. The Y and Z values proceed counterclockwise around each station. Where a triangular panel is formed, identical Y and Z values are input twice.

Items 26 through 32 define the subdivision of the external geometric shape of the fuselage into panels. Item 26 is the descriptive title containing additional information particular to the panel layout. Item 27, designated the KCARD, contains the reference area option and the number of divisions to be used to partition the external geometry into panels. The option K0=0 designates that no reference length card, item 30, will be read. It is followed by five sets of KRADX(I) and KFORX(I), one for each segment. In the pair for the first segment, KRADX(1)=0 and KFORX(1)=7 specify the same meridional spacings as the external geometric shape, while seven axial sections are used to partition the fuselage forward of the inlets into six rings of panels. The next three pairs of KRADX and KFORX define the inlet section panel rings to use the same coordinates input in the external shape. The sample case shows, for these three segments, KRADX=0 and KFORX=2. KFORX could also be input as KFORX=0 in which case the second, third, and fourth cards in item 32 in Figure 11 would be omitted. With KFORX=2 the same axial layout is specified as was input in items 18, 20, and 21. The last segment is partitioned into four axial sections and uses the same coordinates as the input external shape to define the panel edges. The panel layout is shown pictorially for the fuselage in Figure 12. A three-dimension isometric view of the fuselage shownning the body segments and inlets is presented on the first page, Figure 12(a).

Items 28 and 29 define the properties of the inlet including the number of traverses used to define the inlet shock shape, the inlet panel numbers, the panel numbers used in the shock calculation, and the special inlet properties. The first value in item 28, the INLETA card, NIS=3 specifies that three radial traverses will be used to define the inlet shock shape. The next six values on the same card are the panel numbers of the source panels modeling the surface of the inlet face. The first four panel numbers, 60, 61, 74, and 75, designate the open inlet panels. Similarly, the next two panel numbers, 88 and 89, designate the blocked inlet panels. The layout of these panels is depicted in

the fuselage isometric projection in Figure 12(a) and the corresponding rear view in Figure 12(b). The remaining values on the cards of item 28 are the values of JINLT which designate the remaining panel numbers of the set of panels to be used in the inlet velocity computations for the shock shape. These additional inlet panels are indicated on the inlet rear and side views in Figures 12(b) and 12(c), respectively. The value BTINLT=.58 in item 29 is selected to be about 3-4% less than the cotangent of the angle of the panel to the flow (cot 59°=.60).

The five cards of item 32, designated XJ cards, define the axial stations bounding the panel rings in each of the five segments. Each card contains the axial stations dividing the rings of panels. The last value in each segment must also be the first value in the following segment. The fuselage is only paneled aft to body station 45.845.

The next eight items, items 34 through 38 and 40 through 42, are the wing input data. Item 34 gives the position of the wing root chord leading edge relative to the fuselage and the wing incidence angle and item 35 specifies the root chord length and the semispan. These quantities are shown in Figure 10. Items 36 and 37 are data required by the program to lay out the constant u-velocity panels. There are to be 9 panels in each chordwise row and 8 of these rows across the semispan. This requires that the spanwise locations on the left wing panel of nine side edges and the sweep angles and dihedral angle to the right of these points be specified. These data are contained on the nine cards of item 37. Note that the first side edge coincides with the wing-fuselage juncture. Item 38 indicates that the wing has neither twist nor camber, and thus item 39 is omitted from the input data deck. Items 40, 41, and 42 specify the wing thickness distribution. The three indices on item 40 indicate that 50 thickness panels are to be placed in one chordwise row (MSWS=1) and that the wing has a similar thickness distribution at all spanwise stations (NUNIS=1). The single chordwise row of thickness panels is

bounded by the two spanwise stations with leading and trailing edge sweep angles and dihedral angle given in item 41. Item 42 consists of seven cards with the 50 values of the slope of the thickness distribution. The airfoil section specification is shown in Figure 9(a). The wing leading edge in this case is subsonic. The maximum value of the slope has been selected in accordance with the discussion in Section 3.4 of Reference 2.

Since there is a pylon, items 43 through 48 are input and contain the pylon data. The pylon is the one shown in Figure 9(d), except that it has been scaled up by a factor of 20. The pylon as shown in Figure 9(d) extends through the hole in the body duct assembly in Figure 9(c) to attach directly to the body. The height dimension here is the exposed portion of the pylon. Item 43 of the input data specifies that the pylon is located below the fuselage centerline (IP=0), the leading-edge and trailing-edge sweep angles are 0.0°, the root chord length is 4.44 feet, the exposed height is 0.75 feet, and the leading edge is 4.53 feet behind the local wing chord leading edge defined to be the wing root chord for IP=0 (see Figure 10). Items 44 and 45 are the pylon constant u-velocity panel data. There are to be two panels in a chordwise row and two of these rows spanwise. The three side edge locations are given by item 45. Items 46 and 47 specify the pylon thickness distribution. There are to be 40 thickness panels in one chordwise row and the thickness distribution is similar at all spanwise stations. Item 48 contains the slopes of the panels at the centroid of each of the 40 thickness panels.

No rack is present so items 49 through 53 are omitted.

Item 54 begins the store data. The store is shown in Figure 9(e) but has been scaled up by a factor of 20 and the dimensions converted from inches to feet. Item 54 contains the number assigned to the store and its shape number. The value of NSHAPE(1) greater than 50 indicates that this store is to be

modeled using the elliptic store option. The next seven quantities in this item are the store length, maximum radius, location of the store nose, and attachment incidence and roll angles. This information is shown in Figure 10.

Item number 55 contains the value of NSHPT. Only one store shape is input here. Items 56 through 75 contain the shape data for the store. Item 56 contains the value of MSHAPE, which must be equal to the value of NSHAPE(1) read in as part of item 54. The value of MSOR is MSOR=0 since the elliptic store option is being used. It also specifies the store limiting nose shock angle STHSHK=54°. For the elliptic store, the value STHSHK is determined from Chart 5 of Reference 9 for an area equivalent nose semivertex angle of 24.4°.

Items 60 through 75 define the store using the same methods and routines used to specify the fuselage panel layout. The first card, item 60, is the descriptive title for the store shape. Item 61 is the same IOPTS card as in item 14. The first value, IXZSYM=1, specifies the store configuration as symmetric with both halves to be paneled with only the positive-y side of the shape input. The print control, IPRT, prints the input, layout geometry, shock shape, and source distribution and the velocity coefficient data. IUVW=0 requests that the u,v,w velocity coefficients be saved for transmission to Program II. The value NSHOCK=3 specifies that three radial traverses be used to define the store shock shape meridionally at ϕ = 0°, 45°, and 90°. MAXSHK=8 limits the number of radial steps in each traverse to eight. No inlet panels are included or permitted.

Item 62 is the XBIP card. No value is specified for XBIP in Program I. All values for the interference shell will be computed in Program II. The shoulder location XSHLDR=4.167 is used to define the aft end of the store nose. The value EALPHA=0.575 is

obtained from Figure 4 by interpolation of the M=1.5 line to the area equivalent nose semivertex cone angle of 24.4° for the elliptic store. This value of EALPHA=0.575 was obtained from an early version of Figure 4. A more correct value would be 0.61.

Items 63 through 70 define the external shape of the elliptic store. Item 63, the JCARD, defines the options used or read in specifying the store shape. The first value, J0=0, requests that no reference area card (item 64) be read. J2=-5 specifies that the elliptic body option requesting the horizontal semi-axis, BY, and the ratio, A/B be read. The value J6=-1 identifies that top-bottom symmetry exists and that no Z-value, item 66, be read. The value NFUS=1 specifies that only one segment (a program restriction) will be used to define the store body. NRADX=19 and NFORX=23 subdivide the surface geometry into 18 meridional divisions on the half body and uses 23 axial body sections to define the external store shape. The meridional angles on the right half of the store are mirror imaged to the left half to model the full configuration. The meridional angles are computed internally at equally spaced intervals to generate the Y,Z coordiantes on the elliptic shape. Twenty-three values of X, BY, and A/B are input in items 65, 68, and 70.

Item 71 contains the title associated with the store paneling. Item 72, the store KCARD, has three indices. K0=1, requests that the reference area and length card (item 73) be read since forces and moments will be computed later in Program II. KRADX=-5 indicates from the negative sign that the new meridional angles will be read, and from the magnitude that five values will be input to define the right half of the store body. The value, KFORX=19, specifies that 19 x-stations will be used to define 18 rings of eight panels.

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PREDICTION OF SUPERSONIC STORE SEPARATION CHARACTERISTICS INCLU--ETC(U)
NOV 80 J MULLEN, F K GOODWIN, M F DILLENIUS F33615-76-C-3077
UNCLASSIFIED NEAR-TR-210-VOL-2 AFWAL-TR-80-3032-VOL-2 NL

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2 OF 3

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1.0 1.1 1.25 1.4 1.6 1.8 2.0 2.2 2.5 2.8 3.2 3.6 4.0 4.5 5.0 5.6 6.3

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Item 73 contains the reference area and lengths used in the force and moment calculations. REFAR uses the maximum cross-sectional area of 2.4544 ft^2. The reference length, REFD=1.7678 ft, is obtained for an equivalent circular body diameter. The third value, REFL=10.0, is the store body length. It is followed by the x-location of the moment center, REFX=5.0, set to the center of the store. The last value, REFZ=0.0, indicates that there is no z-offset of the moment center.

Item 74 contains the meridional angles used to subdivide the store into panels about the circumference. Five values are input for the store half body. The panel layout defines panel edges at merdians corresponding to the angles of attachment of the interdigitated tail fins. The first and last values, PHI=0° and 180°, must lie on the XZ plane of symmetry. The last item, the two XJ cards, contain the 19 values for the axial stations subdividing the panel layout. This number was chosen to provide sufficient axial resolution of the load distribution in the presence of reflected shocks. It is noted that values XJ=5.833, 8.333, 8.75, and 10.0 correspond to leading and trailing edges of the two sets of fins. These values locate the leading and trailing edges of the two empennages to be defined in Program II for the ejected store as depicted in Figure 13.

3.3 Description of Output from Program I

Figure 14 presents the output from the computer program for the sample case, the configurations of Figure 10, and the data deck of Figure 11.

The first page of output, Figure 14(a), tabulates the input identifying information, the aircraft flight conditions, and the fuselage data input in item 11. The remaining fuselage data describing the noncircular fuselage including inlets is continued over the next five pages. It is followed by the panel geometry, singularity strengths and nose and inlet shock shapes.

Figures 14(b), 14(c), 14(d), and 14(e) repeat the input data for the external geometric shape data for the scaled version of experimental model configuration N3-B2-A4. It starts with the program options and is followed by three pages of Y,Z coordinates for each of the fuselage cross sections in each of the five body segments. At the end of the Y,Z input are the computed maximum cross sectional area, shoulder area and x-locations, and body length between the first and last input stations. If XSHLDR is input the shoulder area is not computed. With these exceptions, all of the above variables are input quantities whose descriptions are found under the definitions of the input variables. All fuselage data printed in this section are controlled by print control IPRT(1).

Figure 14(f) repeats the input for the control parameters and variables which describe the layout of the source panels on the noncircular fuselage. They include the special properties of the inlet panels and the x-stations at which Y,Z data is interpolated in the external geometric shape above.

Figures 14(g) through 14(l) contain the output of the source panel corner points, control points, orientation angles and panel areas as computed for each of the individual panels. This output is controlled by IPRT(2) and represents the primary panel property data passed to the second program. It typically may be helpful in checking geometric input and in identifying panel indices for the inlet panel input.

The first part of Figure 14(m) contains the information for the fuselage interference shell constant u-velocity panels. It includes the number and location of the panels in wing coordinates and the table of Y,Z coordinates obtained from the source panel data to be used as the noncircular cross section defining the interference shell. This section is generated from the external geometry at axial station XBIP. The remainder of Figure 14(m),

and Figures 14(n) and 14(o) tabulate the source panel singularity strengths and the boundary conditions used in their computation.

Figures 14(p) and 14(g) tabulate the nonlinear shock shapes computed for the fuselage nose and for the ramp inlet. These tables form a two-dimensional representation of x-location of the shocks as functions of R and ϕ_s. Tabulated along each radial traverse in the shape integration are the axial location, X, for the prescribed distance R, the axial velocity along the wind axis, U, maximum radial component of velocity, W, the computed local Mach number, M_ℓ, the value of $\beta = \sqrt{M_\ell^2 - 1}$, the local shock slope, DX/DR, the increment in Prandtl-Meyer turning angle due to the local flow, DNU, and the total velocity in the wind axis, UVWSQ.

Figures 14(r), 14(s), and 14(t) tabulate most of the wing and pylon input data. Figure 14(r) tabulates the wing data exclusive of the twist and camber and thickness distributions. Figure 14(s) tabulates the pylon data except for the thickness distribution. The input thickness distributions for the wing and pylon are tabulated in Figure 14(t).

Figures 14(u) through 14(ii) tabulate the input and computed data for the elliptic store. Figure 14(u) contains the store input numbers, length, radius, location, and orientation relative to the local wing chord. For the store located on the centerline, these locations are relative to the projection of the root chord through the body.

Figure 14(v) contains the input control parameters and elliptic store external shape variables. As requested by the option J2=-5, the distributions of horizontal semi-axis and elliptic ratio are input versus axial station. Since the elliptic ratio is constant for the entire store, only the first value has to be input. The computed vertical semi-axis is also shown. Figure 14(w) contains the tabulated values input for the control

parameters which are used with the input geometry to divide the store into discrete panels. The reference lengths and areas, the meridional partitioning of circumference and the axial stations subdividing the rings are shown.

Figures 14(x) through 14(cc) contain the store source panel corner points and computed geometric properties as controlled by the store print control IPRT(2). Two singularity strength solutions are computed when the store is at angle of attack. The two are given in Figures 14(cc) through 14(ii). The singularity strengths and boundary conditions for the store at $\alpha_c = 0°$ are shown in Figures 14(cc) through 14(ff). The shock shape tabulated for the store at zero degrees angle of attack is presented in Figure 14 (ff) for the three radial traverses. This shock shape is rotated about the store later as needed for use at angle of attack. Second, the store singularity strengths computed at the input angle of attack are shown in Figures 14(gg) through 14(ii).

The next three pages of output, Figures 14(jj) through 14(ll), tabulate quantities associated with the constant u-velocity panel layout on the wing, pylon, and fuselage and the boundary condition at the control points of these panels. The x,y,z coordinates are those of the control points in the wing coordinate system, see Figure 3. The next three columns, U/VINF, V/VINF, and W/VINF, are the sums of the dimensionless perturbation velocities in the x_w, y_w, and z_w directions, respectively, induced at the control points by the other aircraft components. These include fuselage on the wing and pylon, wing thickness on pylon, wing thickness on wing when wing has dihedral, pylon thickness on wing, and both wing and pylon thickness on the fuselage. VINF is the free-stream velocity. The next to last column tabulates the twist and camber distribution input for the wing. The last column tabulates the singularity strengths of the constant u-velocity panels laid out on the wing, pylon, and fuselage.

3.4 External Dataset Generated by Program I

At the end of the execution of the first program to compute the parent aircraft flow model, the data required to be passed to the second program is written on the external file TAPE12 by routine WRFILE. This data contains some of the input parameters and computed quantities from Program I.

It is the user's responsibility to provide the job control language, JCL, necessary to manipulate and save the data on TAPE12 to transmit it to Program II. Multiple runs with Program II may then be made with the same dataset. If the programs are to be run sequentially in the same job stream, no additional JCL other than to see that the data is not lost is required. Tape rewinds are taken care of internally in the program.

There are nine sections of data as written from routine WRFILE. The data consists of one section for each of: program indices, program constants, u-velocity panel data, thickness panel data, either line source or source paneling fuselage data, pylon data, rack data, and circular and elliptic store data. For the details of the variables written see the program listing in Figure A-1 of Volumne III. All variables written were either residing in blank or labeled common at some point in the program execution. The individual descriptions of the variables may be found in Appendix B of Volume III.

When using both noncircular options for store and fuselage this file may be quite voluminous. For the sample case in Figures 11 using 137 source panels on the fuselage and 144 source panels on the elliptic store the dataset required 850 sectors (640 characters/sector) of external storage on a CYBER-175. The largest single items saved are the aerodynamic influence coefficient and U,V,W, component velocity matrices for the store to be separated. Each of these four contain about N(N+1)/2 elements.

When two elliptic store shapes exist, use of the IUVW option in item 61 can avoid the unnecessary saving of these as appropriate. If only one shape is to be separated, the index IUVW can be set to IUVW=1 for the other shape.

3.5 Program Error Messages

The possible occurrence of certain fatal errors and irresolvable conflicts of data during program execution has been anticipated in Program I. If such errors should occur, the program has been designed to print a diagnostic error message and halt when appropriate. Each message with the routine in which the corresponding error is detected is presented in the following table. The program tests which resulted in the section are also included.

Routine	Program Action	Error Message
LDCALC	STOP	** NSTRS input as __, program limited to seven stores. (Test: NSTRS > 7)
BDYGEN	STOP	** At base of body radial distance to Mach cone emanating from body nose is less than maximum body radius check input data and Mach number. (Test: BETA*RADIUS<BODYL*XEND(NSEG))
	STOP	** Mach cone-body meridian intersection not found after 100 trials. (Test: ITRY > 100; loop from 40 to 39)
BODVEL	STOP 100	(Test: NER > 0, indicates $\lvert A(NER,NER)\rvert < 10^{-20}$ in PAS001)

Routine	Program Action	Error Message
GEOM	STOP 320	Error - total number of external geometry axial stations exceeds 50 - GEOM (test: NX > 50)
	STOP 330	Error - maximum number of meridional cuts exceeds 33 - GEOM. (Test: MAXKR > 33)
	STOP 340	Error - maximum number of segments exceeds 5 - GEOM. (Test: NFUS > 5)
	Warning only	Warning - Blank common required for GEOM = ___ exceeds dimension = ___. (Test: NATOT > NADIM)
INVER1	STOP	** Matrix is singular (Test: A(I,I)=0.0)
SORPAN	STOP 230	** Mach number less than 1, SORPAN (Test: AMACH < 1)
	STOP 220	Error - body panel slope exceeds Mach angle, J = __ - ** SORPAN ** (Test: $1.-BETAL^2*TAND^2 \leq 0.$)
STORIO	STOP 707	Shape data not input for all stores - ** STORIO ** (Test: NCOUNT $\neq$ NSTRS)
WITHIN	STOP	** Slope of wing thickness envelope at leading edge not positive for some chordwise row. (Test: THETAL(JLE) $\leq$ 0.)

If one of the above messages is printed out during program execution, the user should consult the input data first for possible error. The program variable descriptions in Appendices A and B of Volume III may also be helpful for the meanings of the above test quantities.

3.6 Program I Running Times

The first program described in this report has been run on both the CDC 6600 and CYBER-175 machines. Because of machine differences, the running time varies from one machine to the other. As a consequence, only an approximate running time can be given. The first program can be run only once for multiple trajectory calculations, thus its percentage of the total trajectory calculation time will vary.

The running time for the calculation of the singularity strengths associated with the parent aircraft and its components is a function of a number of factors, some of which are:

(a) Number of sources and doublets required to represent circular fuselage, rack, or store bodies.

(b) Number of source panels used to represent the non-circular fuselage or elliptic stores.

(c) Number of constant u-velocity panels on the wing and pylon.

(d) Number of traverses used to define the nonlinear shock shapes associated with source panel modeling of fuselage or stores.

All of the above should be kept to a minimum required to resolve the separating store loads. For the sample case for the first program in Figure 14, the run time was about 55 seconds on the CYBER-175.

4. DETAILS OF THE USE OF PROGRAM II

The second program to integrate the trajectory of the separated store consists of a main program and 106 subroutines. Appendix C of Volume IV presents a detailed description of the flow of calculations in each of these routines. Table C-1 in Appendix C lists these subroutines in alphabetical order and gives a one-sentence description of what each subroutine does. A listing of the routines in Program II is presented in Figure C-1. A general flow chart of the main program for Program II (TRJTRY) is presented in Figure 15 of this report. The program as written in Figure C-1 adheres to ANSI FORTRAN standards. Only the first card is specifically for the CYBER-175 series machines. The following sections outline the flow of calculations as presented in the flow chart of the main program, TRJTRY, the preparation of input cards, the descriptions of the output, and any special conditions and messages encountered within the program.

4.1 General Flow Chart of Program II

The purpose of the second program is to define the properties of the separating store including any empennages and to integrate the six-degree-of-freedom equations of motion which are derived in Appendix B of Reference 1. The separating store may be circular with a single empennage or elliptic in shape with one or two sets of arbitrarily oriented fins. The elliptic option may also be used for a circular store.

A general flow chart of the second program is presented in Figure 15. Page 1 of the flow chart describes the sequence of reading the external dataset containing the parent aircraft data and of reading the input defining the separating store and any empennages on it. Constants are first defined and additional heading information is read and printed. The external file

containing the parent aircraft and store body information generated in Program I is then read by a call to RDFILE. Any elliptic store data or noncircular fuselage data are copied by that routine onto TAPE10 and TAPE11, respectively. The aircraft flight conditions are input and compared with those on the dataset from Program I; if a mismatch occurs the job is terminated.

If a store is present, the program reads in the additional data required to describe the store to be separated. If an ejector is used, the force histories are read. The store mass and inertia properties are input as are the indices specifying the ejected store options. If the ejected store is circular in shape the body geometry is read. If a noncircular fuselage or elliptic stores exist, their data are copied sequentially into blank common in STRDAT.

If the store to be separated is circular and has an empennage, the data required to describe the empennage are input and subroutine SEMPIN is called to initialize the force and moment calculation. If the store to be separated uses the elliptic model, one or two sets of arbitrarily oriented fins can be input. The locations of the finned sections on the body are read and the appropriate indices of body panels computed in IXBOD. The empennage data are input and u-velocity panel influence coefficient matrix is computed in CRFWBD. If two empennages exist, all data in labeled commons necessary to restart the calculations and the influence coefficients are written on TAPE3 for later reuse.

As shown on the second page of the flow chart, Figure 15(b), the program next reads in polynomials specifying the thrust time history if this option is being used.

The provision is made in the program for prescribing initial translational and rotational velocities relative to the parent

aircraft. These are next read and the initial values of the 12 dependent variables in the trajectory calculation computed. These are:

(1) The three coordinates of the store center of moments relative to the fuselage nose.

(2) The three translational velocity components of the store center of moments relative to the fuselage.

(3) The three store rotational velocities.

(4) The three angles giving the store orientation relative to the fuselage.

Reference positions of the store nose, center of moments, and base are next calculated and the initial and final trajectory times, as well as the integration interval, are input. If the initial time is not zero, then the trajectory is being restarted from a previous run and the current values of the 12 dependent variables obtained from that run are read in. The last steps in the initialization are to compute the ejector force at $T\text{-}T_{INITIAL}$ and to initialize subroutine ADAMS, the integration routine.

The remainder of the flow chart, Figure 15, is the integration loop of the program. The first steps are to calculate the aerodynamic forces and moments acting on the body and the empennage(s), if present, of the separating store. Different methods are used for each of these calculations depending on whether the circular or elliptic store model is used. If the store is circular, the body forces and moments are determined by using the equations presented in Appendix A of Reference 1. The empennage forces and moments are determined as discussed in Section 5.3 and Appendix I of Reference 6.

If the elliptic store model is used, the body forces and moments are computed in SFORC2 using the body source panels described in References 12 and 13. The store body solution includes the presence of the parent aircraft and any image store resulting from shock reflections off fuselage or wing surfaces. If a single empennage is present the forces and moments are computed for the u-velocity panels in DEMON2 according to the methods described in Reference 14. This solution includes the presence of the parent aircraft and any body nose shock reflections. If a second empennage is present, the trailing edge vorticity generated by the first empennage may be integrated aft, for certain configurations, to the leading edge of the second set of fins. Due to the size of the data arrays involved, the fuselage data must be saved temporarily on TAPE7 while the empennage calculations are performed. The data for each set of empennages must be brought in from external storage during its computation.

One of the options in the computer program is to calculate a wind-tunnel captive-store trajectory as opposed to a free-flight trajectory. It is customary in the wind tunnel to change the store orientation relative to the parent aircraft while measuring the forces and moments in order to approximately account for the store translational motion relative to the aircraft. The computer program also does this during the force and moment calculation. Thus, if a captive-store trajectory is being calculated, the next step in the program is to put the store back to its correct orientation and call subroutine DIRCOS in order to calculate the free-flight direction cosines between the store body coordinate system and the inertial coordinate system fixed to the fuselage.

The next series of steps determines the store translational and rotational accelerations. This involves solving the set of six simultaneous equations given by Equations (B-16) through (B-18) and (B-41) through (B-43) of Appendix B of Reference 1

making use of the relationships given in Section 7 of that reference. The coefficient matrix is first calculated and then the right-hand sides are determined. Subroutine INVER2 is called to solve the set of six equations for the accelerations. The rates of change of the orientation angles are next determined from Equation (B-1) of Appendix B of Reference 1.

A check is next made to see if output is to be printed at the end of an integration step. If output is not required, the integration continues by calling subroutine ADAMS. If it is required, subroutine SOUTPT is called. Upon return from this subroutine a check is made to see if the time is equal to or greater than the final time which was read in and, if so, the trajectory is stopped. If it is not, the integration is continued.

4.2 Input Data

This section of the report will describe in detail the preparation of the input data deck for Program II. Only the data read from the input data deck is described here and not the data generated in Program I which is transferred on TAPE12. Program II reads the data required to define the separating store and its empennages and to initialize the store trajectory calculation.

4.2.1 Input formats

The format for the input data for Program II is shown in Figure 16. Four lines of information are shown for each item. The first line gives the item number, how many and when the cards are read, and the routine in the program in which the data is actually read. The second line gives the program variable names, the third line shows the card column fields into which the data are to be punched, and the fourth line shows the FORTRAN format

type. Data punched in I and E formats are right justified in the fields whereas data in F format can be punched anywhere in the field. A decimal point should be included in both E- and F-type data.

4.2.2 Input descriptions for Program II

Two input files are read by Program II. The first is read from cards via unit 5 on the computer. The second file is read from an unformatted disk file on unit 12 that was previously generated by Program I. The descriptions of variables here are for the input cards read on unit 5.

Item number 1 has an index NCARDS which indicates how many cards of information are to follow to identify the run, item number 2. The value of NCARDS must be one or greater.

Item number 2 is a set of NCARDS cards containing hollerith information identifying the run. This information may start and end anywhere on the card. The cards are reproduced in the output just as they are read in.

Item number 3 consists of one card containing the following flight condition information.

Item 3:

ALFA	fuselage angle of attack, degrees
GAMF	fuselage flight path angle, degrees
CMACH	Mach number
RHO	air density at flight altitude, slugs per cubic foot
VINF	aircraft free-stream velocity, feet per second

The values of ALFA and CMACH must be identical to those values of ALFAC and FMACH read in item 3 of Program I. The values of ALFA and CMACH are compared with ALFAC and FMACH on TAPE12. If either value fails to compare, program execution is terminated. The aircraft is assumed to be flying in a straight line; however, it can be climbing or diving. For climbing flight, GAMF is positive. The Mach number should be between 1.2 and 3.0 and the angle of attack should not exceed 10° for the flow models to be valid.

Item number 4 is one card which contains eleven indices. They are:

Item 4:

NEJECT	number of the store being separated
NSEG	number of equal length segments the body is to be broken into for the force calculation; NSEG $\leq$ 40; NSEG=0 for elliptic store option
NSORCE	number of line sources and doublets to be used to model the store volume and angle of attack effects; NSORCE $\leq$ 100; NSORCE=0 for elliptic store option
NGAM	trajectory to simulate wind-tunnel captive-store trajectory? NGAM=0, no NGAM=1, yes
NPOLY	number of polynomials specifying store shape; 1 $\leq$ NPOLY $\leq$ 7; NPOLY=0 for elliptic store option
NROLL	rolling moment to be calculated? NROLL=0, no NROLL=1, yes

NEMP empennage present?

NEMP=0, no

NEMP=1, yes, single set of fins

NEMP=2, yes, for elliptic store option only, include two sets of fins

NDAMP damping to be included in force calculation?

NDAMP=0, no

NDAMP=1, yes

NTHRUS thrust time history to be specified?

NTRHUS=0, no

NTRHUS=1, yes

NTHETA number of theta stations around the full circumference of store body used in pressure calculations; NTHETA $\leq$ 37. NTHETA must further be an odd value. NTHETA=0 for elliptic store option

NJECTR ejector present?

NJECTR=0, no

NJECTR=1, yes

The index NEJECT must correspond to one of the store numbers that were read into NUMSTR in item 54 of Program I; that is, NEJECT=NUMSTR(J). The shape number of this store is NSHAPE(NEJSTR) where NEJSTR=J. If NSHAPE(NEJSTR)$\leq$50 the circular store option will be used. The NSHAPE array was input in item 54 of Program I. The variables NSEG, NSORCE, NPOLY, and NTHETA are only required by the circular body modeling of the store.

In the circular store body force and moment calculations, the body is divided into NSEG equal length segments. Experience in using the program has shown that 20 body segements, NSEG=20, usually yields converged forces and moments. This can only be checked for a specific case by varying NSEG and comparing results. To minimize calculation time NSEG should be kept as small as

possible. For elliptic store bodies, NSEG is internally set equal to the number of rings of panels as determined from KFORX for the store, input item 72 of Program I.

NSORCE defines the same information as MSOR in item 56 of the first program for the store to be separated. Though the variables are identical, there is no requirement that they have the same value. More or less sources and doublets may be used as necessary for the accuracy of the predictions.

The index NGAM is included as input for the purpose of allowing the program to be used to compare with captive store data obtained in the wind tunnel. Since the wind tunnel cannot produce a flow where the store sees a free-stream velocity coming from a different direction than that seen by the parent aircraft the captive store case must be handled differently by the computer program.

The number of polynomials specifying the circular store shape, NPOLY, is the number required to specify the shape from the store nose to its base. These polynomials are used in the force and moment calculation. The polynomials are of the form given by Equation (1). The value of NPOLY may be equal to the value of NSPOLJ read under item 57 in Program I. It is used only by the circular store option.

The next index, NROLL, indicates whether or not the rolling moment for a store with an empennage is to be calculated. NEMP specifies whether there are empennages present. For the circular body option, only one empennage may be modeled using the slender-body methods detailed in Reference 6. This option is restricted to monoplane and cruciform fin configurations. For the elliptic store option, there may be one or two sets of empennages. Each of these are modeled using constant u-velocity panels and consist of an interference shell and from one to four arbitrarily oriented

fins. The index, NDAMP, is used by the program to determine whether or not aerodynamic damping in pitch, yaw, and roll is to be included in the force and moment calculation. The index, NTHRUS, specifies whether a thrust time history is to be read. If present, items 29, 30, and 31 are read.

The index, NTHETA, sets the number of stations used in the pressure integration around the circumference of the body for the circular store option. This includes the requirements that the first and last points be the same and that the number be odd to maintain body symmetry. The last index, NJECTR, determines whether an ejector is used during the store separation. If a blank or zero is input the option is not used. However, setting NJECTR=1 causes the ejector model to be activated. In this case, the additional items 5, 6, 7, and 8 are read to specify the ejector forces and moments versus time or distance. The value of one is used to initiate reading of the input values in routine EJECTR. On return it is internally reset to 2 to next compute the ejector foot location and forces and moments at time equals zero. It is again internally reset to NJECTR=3 for the remainder of the trajectory calculations.

Item numbers 5 through 8 are used to specify the ejector time or displacement histories. If NJECTR in item 4 is input as NJECTR=0 these items are omitted. Item number 5 is used to specify the ejector options as follows:

<u>Item 5</u>:

NFEET — number of ejector feet; NFEET $\leq$ 2

NSTRKE — switch specifying whether time or stroke will be independent variable:
- NSTRKE=0, time or stroke exceeding limits terminate ejector forces and moments
- NSTRKE=1, ejector stroke is sole criterion for termination of ejector forces

Exceeding either of the termination criteria will cause the ejector forces and moments to be set to zero. If time is to be the sole criterion for ejector termination, use the option NSTRKE=0 and set STROKE(I) in item 6 equal to a large number.

The ejector model has the capability of modeling 1 or 2 ejector feet. The ejector is assumed to act in a plane perpendicular to the fuselage longitudinal axis (the X_B axis, see Figure 5). It is also assumed that the ejector acts in the plane containing the store longitudinal axis when the store is in the carriage position. The ejector foot has no volume: i.e., the ejector foot is assumed to be a line. The rack/aircraft structure is rigid: i.e., the rack transmits 100% of the force to the store.

The next two items, items 6 and 7, are repeated as a set NFEET times; one for each ejector foot. The first card, item number 6, specifies the ejector location and movement as follows (I=1,NFEET):

Item 6:

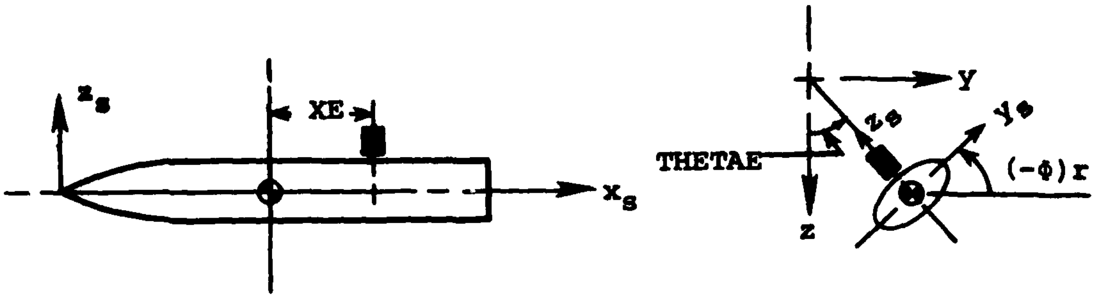
NEPOLY(I) — number of 5th order polynomials used to specify the Ith ejector foot's force as a function of the independent variable

XE(I) — longitudinal distance along the store centerline to the Ith foot; feet, measured positive aft from moment center.

THETAE(I) — angle between the vertical and the line of action of the ejector foot; measured positive counterclockwise viewed from rear, degrees

STROKE(I) — stroke length of the Ith foot; feet

The polynomial independent variable may be time or distance as specified by NSTRKE. The sense of XE is positive along the x_s axis in Figure 17, with the origin shifted to the store moment center; i.e., XE(I) is negative if the foot is between the center of gravity and the store nose. The positive sense of XE and THETAE are shown in the sketch below.



The second card, item number 7, contains the end points of the NEPOLY(I) polynomials as follows:

<u>Item 7</u>:

TEEND(I,J) time or stroke end points of ejector force polynomials for Ith ejector and Jth polynomial, $1 \leq J \leq$ NEPOLY(I)

The dimensions of TEEND are of time in seconds or feet depending on the independent variable specified by the option NSTRKE. Both variables are assumed to start at zero at time equals zero. Only NEPOLY(I) values need to be input on each card.

Item number 8 consists of NEPOLY(I) cards for each ejector foot, each containing the coefficients of a single polynomial as follows:

Item 8:

AKE(I,J) each card contains coefficients $C_0, C_1, C_2, C_3, C_4, C_5$ for a single 5th order polynomial

The units are force F(I) in pounds with the independent variable X of time or distance in seconds or feet. The coefficients are for a polynomial of the form:

$$F(I) = C_0 + C_1X + C_2X^2 + C_3X^3 + C_4X^4 + C_5X^5$$

where X is the independent variable of time or stroke length. This group contains $\sum_{I=1}^{NFEET}$ NEPOLY(I) cards. The cards begin with the coefficients for the polynomials consistent with the input for I=1. Coefficients for the second foot (I=2) if NFEET=2 follow immediately after those for the first foot.

Item number 9 is one card and specifies the store mass and inertia characteristics. The quantities are:

Item 9:

SMASS	store mass, slugs
FIXX	I_{xx} moment of inertia, slug-ft^2
FIYY	I_{yy} moment of inertia, slug-ft^2
FIZZ	I_{zz} moment of inertia, slug-ft^2
FIYZ	I_{yz} product of inertia, slug-ft^2
FIXZ	I_{xz} product of inertia, slug-ft^2
FIXY	I_{xy} product of inertia, slug-ft^2

The equations defining the moments and products of inertia are given by Equation (B-36) of Appendix B of Reference 1.

The one card of item number 10 contains:

Item 10:

XMOM	location along store axis about which the pitching and yawing moments are to be taken, negative behind nose, feet; same point about which moments of inertia are taken; for elliptic store XMOM must be the same as REFX input in item 73 of Program I
XBAR	x location of store c.g. measured from moment center, feet; positive forward toward the nose
YBAR	y location of store c.g. measured from store axis, feet; positive to the right looking forward
ZBAR	z location of store c.g. measured from store axis, feet; positive down viewed from the rear

The next two items of input, items 11 and 12, describe the shape of a separated circular store. They are omitted if NSHAPE(NEJSTR)>50. The quantities contained on the cards are:

Item 11:

XEND(J)	x/ℓ of end points of polynomials specifying shape of ejected store, NPOLY values

Item 12:

COEF(J,K)	coefficients of polynomials specifying shape

These data are a repeat of the data input as items 58 and 59 in Program I.

Item number 13 contains one quantity which is

CA	store axial-force coefficient; reference area is store maximum cross-sectional area for the circular store option and equal to REFAR of item 73 of Program I for elliptic store option

The store axial-force coefficient is not calculated by the computer program so it is required input.

The next two items of input data, items 14 and 15, are included in the input data deck for the circular store option if an empennage is present; NEMP=1, in item 4 and NSHAPE(NEJSTR) less than or equal to 50.

Item 14:

IPLNR — IPLNR=0, cruciform empennage
IPLNR=1, planar empennage

MSF — number of spanwise control points on each fin; must be odd and $5 \leq$ MSF ≤ 11

For most stores, MSF=5 has been found to give accurate results. The larger the fin span to body radius ratio, the more points required.

Item 15:

XTAIL — x location at which empennage forces are to act measured from store nose, feet; negative number

RADAV — average store body radius in empennage region, feet; positive number

FINSS — tail fin semispan, measured from body longitudinal axis, feet; positive number

PHIROL — initial fin orientation, degrees; $0° \leq$ PHIROL $\leq 90°$; PHIROL = 0° if fins vertical and horizontal for a cruciform empennage or horizontal for a planar empennage

CLALPH — lift-curve slope of two exposed panels joined together, per radian; reference area is store maximum cross-sectional area

The location at which the empennage forces are assumed to act, XTAIL, is arbitrary. It can be estimated using Chart 10 of Reference 15. The lift-curve slope, CLALPH, can be estimated using the method described as follows. The value of the tail-fin lift-curve slope, C_{L_α}, can be determined using Reference 15; however, the value of C_{L_α} from Chart 8 of that reference must be modified in order to use the empennage force calculation method incorporated into the computer program. This method assumes full lift carryover onto the body due to the tail fins. At supersonic speeds this is not the case, particularly when the body ends at or near the trailing edge of the fins.

A method for determining the value of the lift-curve slope which accounts for the reduced lift carryover will now be presented. The modified lift-curve slope is calculated using Charts 1, 4, and 8 of Reference 15 and the following equation:

$$C_{L_\alpha} = C_{L_{\alpha_T}} \frac{S_T}{S_R} \left[\frac{K_{T(B)_1} + K_{B(T)_4}}{K_{T(B)_1} + K_{B(T)_1}} \right] \tag{10}$$

The value of $C_{L_{\alpha_T}}$ is obtained from Chart 8. The aspect ratio used is that of two of the exposed panels joined together. The reference area (S_T) used in forming this coefficient is the area of the two fins joined together. Thus, it is multiplied by the ratio of this area divided by the reference area (S_R) used in the computer program, the store maximum cross-sectional area. This is the ratio S_T/S_R.

The quantities in the bracketed term are lift ratios and are obtained from Charts 1 and 4 of Reference 15. The number subscripts in Equation (10) refer to the chart number. The denominator in this term is the sum of the lift ratios for full lift carryover onto the body. The numerator accounts for only

partial lift carryover onto the body. In determining the value of $K_{B(T)4}$ from Chart 4, $(C_{L_\alpha})_W$ is $C_{L_{\alpha_T}} S_T/S_R$, the quantity multiplying the bracketed term in Equation (10).

It is recommended that Chart 4 be used for low-aspect-ratio as well as high-aspect-ratio tail fins. Reference 15 recommends that Chart 4 only be used when the aspect ratio parameter defined there is greater than 4.0. The use of this chart in determining $K_{B(T)4}$ for values of the aspect ratio parameter of 3.0 and 2.25 has resulted in good agreement with experimental data for two different stores in uniform flow. Items 14 and 15 are omitted for elliptic store shapes, NSHAPE(NEJSTR) greater than 50.

The next 13 items of input are used to define the empennage(s) for the elliptic store option. Omit items 16 through 28 if NEMP equals zero or NSHAPE(NEJSTR)≤50. Item number 16 is used to partition the store into body alone and body-fin sections and contains the following information on one card.

Item 16:

NBOD — number of body and body-fin sections; NBOD ≤ 5

XBOD(I) — trailing edge of Ith body or body-fin section, feet; I=1,NBOD

LFIN(I) — logical variable defining Ith section to be body-alone or body-fin section; I=1,NBOD
LFIN(I)=T(true), section contains both body and fins
LFIN(I)=F(false), section contains only body

The data on this card are used to partition the body into interfering and noninterfering sections. The values of XBOD define the body sections. XBOD(1) is the end of the first body section. The XBOD values are compared with the XJ values of the source

panel boundaries to determine those panel rings which interfere with the fins. They must correspond to panel edges.

The next 12 items define an empennage consisting of from one to four fins and a body interference shell. Include one set of items 17 through 28, as required, for each of NEMP empennages. They define the layout of the constant u-velocity panels and the geometric parameters not available in the store description.

Item number 17 consists of one card with the alphanumeric description of the empennage.

Item number 18 consists of one card with the following indices. The fin number system is shown in Figure 18.

Item 18:

MSWR	number of constant u-velocity panels in spanwise direction on right (R) or first (1) fin; $1 \leq MSWR \leq 19$
MSWL	number of constant u-velocity panels in spanwise direction on left (L) or second (2) fin; $0 \leq MSWL \leq 19$
MSWU	number of constant u-velocity panels in spanwise direction on upper (U) or third (3) fin; $0 \leq MSWU \leq 19$
MSWD	number of constant u-velocity panels in spanwise direction on lower (D) or fourth (4) fin; $0 \leq MSWD \leq 19$
NCW	number of constant u-velocity panels in chordwise direction, same for all four fins

NCWB	number of constant u-velocity panels in the longitudinal direction on the surface of the body over the body interference length, BIL. BIL is input in item 23.
NBDCR	number of constant u-velocity panels on the full circumference of the body. If NBDCR=0, NBDCR is set to KRADX-1 from the store body description.
LVSWP	spanwise breaks in fin option; LVSWP=0, no breaks in fin leading or trailing edge sweep angles; equal spanwise spacings of panels LVSWP=1, up to 19 breaks in fin leading or trailing edge sweep angles; that is, up to 19 unequal spanwise spacings

The spanwise number of panels per lifting surface is used to determine the presence of each of the four fins. Only the first fin, corresponding to MSWR, must have a nonzero value. A zero value for the remaining spanwise panel numbers eliminates the lifting surface. The spanwise number of panels may differ from one fin to another but the chordwise number NCW is the same for all. The specification of a nonzero number of body interference panels, NBDCR, on the circumference may be used to override the internal default value which is set equal to the number of source panels around the circumference. The default value is recommended. The number of body interference panels in the axial direction, NCWB, should be set equal to the number of chordwise panels on the fins except where the interference shell length, BIL, spanned by the lifting surfaces differs from the fin root chord. In this case, NCWB follows the rules for defining NCWB for the wing in item 9 of Program I. The control index LVSWP indicates whether breaks in leading-edge and/or trailing-edge sweeps are to be input. If LVSWP=0 the sweep angles, SWLEP, SWTEP, SWLEV, and SWTEV are input in items 19 and 20 and items 25 through 28 are

not included in the input deck. If LVSWP=1, the angles SWLEP, SWTEP, SWLEV, and SWTEV in items 19 and 20 need not be specified, but items 25 through 28 must be included in the input deck.

The numbers of spanwise and chordwise panels are limited by the dimensions of the program. Three dimensions within the program limit the number of panels. The total number of u-velocity panels on the fins and interference shell is limited to 250 with a required blank common array size of 62,500 decimal. The total number of u-velocity panels on the interference shell is limited to 100. The number of spanwise panels on the fins is limited to 19. Thus, the program limitations are:

$$(\mathrm{MSWR}+\mathrm{MSWL}+\mathrm{MSWU}+\mathrm{MSWD})*\mathrm{NCW} + \mathrm{NBDCR}*\mathrm{NCWB} \leq 250$$

with

$$\mathrm{NBDCR}*\mathrm{NCWB} \leq 100$$

and

$$\left.\begin{array}{l}\mathrm{MSWR}\\ \mathrm{MSWL}\\ \mathrm{MSWU}\\ \mathrm{MSWD}\end{array}\right\} \leq 19$$

The next two items of input, items 19 and 20, specify the root chords, spans, and sweep angles for the two pairs of fins, fins 1 and 2 and fins 3 and 4, shown in Figure 18. If there are breaks in leading- and trailing-edge sweep, the sweep angles in items 19 and 20 are input as zero and items 25 through 28 as required are included in the input deck.

For the constant sweep option, item number 19 defines the planforms of both the right and left (horizontal) lifting surfaces (fins 1 and 2). It consists of one card with the following information.

Item 19:

CRP	horizontal fin root chord at the fin-body juncture, feet
SWLEP	horizontal fin leading-edge sweep angle measured in fin planform plane, positive for sweep back, degrees
SWTEP	horizontal fin trailing-edge sweep angle measured in fin planform plane, positive for sweep back, degrees
B2	exposed horizontal fin semispan, feet

For the constant sweep option, item number 20 defines the planforms of both the upper and lower (vertical) lifting surfaces (fins 3 and 4). It is included in the input deck if either MSWU or MSWL of item 18 are greater than zero and consists of one card with the following information.

Item 20:

CRPV	vertical fin root chord at the fin-body juncture, feet
SWLEV	vertical fin leading-edge sweep angle measured in fin planform plane, positive for sweep back, degrees
SWTEV	vertical fin trailing-edge sweep angle measured in fin planform plane, positive for sweep back, degrees
B2V	exposed vertical fin semispan, feet

The designation of horizontal and vertical fins used here only has meaning for planar and cruciform fins. See Figure 18 for the fin number definitions for interdigitated and arbitrarily located fins. It is a program limitation that requires that fin geometry must be input in pairs with this description. That is, fins 1 and 2 have the same geometry as do fins 3 and 4. The

root chord for the fin-body combination is the line formed by the junction of the lifting surfaces and the body. The semispan is measured from the root chord. If different fin geometry is required, use the LVSWP=1 option.

Item number 21 consists of one card with the following fin angular information. This card specifies an interdigitated tail configuration as shown in Figure 18. If there are less than four fins or if the configuration is cruciform with the fins vertical and horizontal, PHIDIH and THETIT are input as PHIDIH=THETIT=0.0° and item 22 is included in the input deck. The fin deflection angles, however, are included in item 21.

Item 21:

PHIDIH	dihedral angle associated with interdigitated fin, measured from the horizontal axis (see Figure 18), $0° \leq$ PHIDIH $\leq 90°$
THETIT	polar angle of meridian associated with intersection of interdigitated fin with store body, measured from horizontal axis (see Figure 18), $0° \leq$ THETIT $\leq 90°$
DELR	δ_R, deflection angle of horizontal right fin (fin 1); positive trailing edge down, degrees
DELL	δ_L, deflection angle of horizontal left fin (fin 2); positive trailing edge down, degrees
DELU	δ_U, deflection angle of vertical right fin (fin 3); positive trailing edge down, degrees
DELD	δ_D, deflection angle of vertical lower fin (fin 4); positive trailing edge down, degrees

If case involves interdigitated fins:

δ_R applies to right upper fin, trailing edge down is positive

δ_L applies to left lower fin, trailing edge down is positive

δ_U applies to right lower fin, trailing edge down is positive

δ_D applies to left upper fin, trailing edge down is positive

The representation of the angles PHIDIH and THETIT for the interdigitated tails on an elliptic cross section body is given in Figure 18. The meaning of the interdigitated angles for each of the four fins is defined on the figure. The deflection angles are defined only for a rigid rotation of the entire control surface. These angles are used only in the specification of the surface boundary conditions.

If an interdigitated tail configuration is not used (THETIT=0.0), item number 22 defines the dihedral and polar angles which locate each of the four fins.

Item 22:

PHIFR	dihedral angle of right fin (fin 1), degrees
PHIFL	dihedral angle of left fin (fin 2), degrees
PHIFU	dihedral angle of upper fin (fin 3), degrees
PHIFD	dihedral angle of lower fin (fin 4), degrees
THETR	polar angle of intersection of right fin (fin 1) with body, degrees
THETL	polar angle of intersection of left fin (fin 2) with body, degrees
THETU	polar angle of intersection of upper fin (fin 3) with body, degrees

THETD	polar angle of intersection of lower fin (fin 4) with body, degrees

All angles are measured from the horizontal axis (Y-axis). The right and upper fin angles are measured counterclockwise from the positive Y-axis. The left and lower fin angles are measured counterclockwise from the negative Y-axis. This designation is based on laying out cruciform fins in symmetric pairs where PHIFR=PHIFL=THETR=THETL=0° and PHIFU=PHIFD=THETU=THETD=90°.

Item numbers 23 and 24 define some additional empennage parameters as follows.

<u>Item 23</u>:

BIL	length of body influenced by fins to account for interference. For fins with no trailing edge sweep, BIL=CRP
VRTMAX	maximum magnitude of vortex induced velocities included in flow tangency condition; use 0.35 as default value

<u>Item 24</u>:

NVRTIN	option to override vortex tracking calculation for multiple empennages; NVRTIN=0, vortex from forward lifting surfaces are integrated back to leading edge of aft fins NVRTIN=1, no vortex influence is computed for aft fins

The variable BIL follows the same definition rules as BODYPL in item 10 of Program I. See item 2, Appendix J of Reference 14 for implications of use of variable VRTMAX. NVRTIN has no meaning when only one empennage exists or for integration of vortex paths aft of second empennage.

Item numbers 25 through 28 define the optional planform descriptions for fins with breaks in leading-edge and/or trailing-edge sweep. They are only included in the input deck when LVSWP=1 in item 18. The following quantities are defined for each of the four fins.

Item number 25 is the optional input for the right fin (fin 1). It is included if LVSWP=1 in item 18.

Item 25:

YRT(KJ)	distance from fin root chord to the constant u-velocity panel outboard side edge on the right fin; $1 \leq KJ \leq MSWR+1$; ($MSWR \leq 19$); YRT(1) = 0.0; YRT(MSWR+1) = B2 of item 19
VSWLER(KJ)	leading-edge sweep of fin between YRT(KJ-1) and YRT(KJ), positive for sweep back, degrees; $1 \leq KJ \leq MSWR+1$; VSWLER(1) = 0.0
VSWTER(KJ)	trailing-edge sweep of fin between YRT(KJ-1) and YRT(KJ), positive for sweep back, degrees; $1 \leq KJ \leq MSWR+1$; VSWTER(1) = 0.0

The optional input of this item is associated with a fin-body combination with breaks in leading-edge and/or trailing-edge sweeps. This input should be used also for configurations if the constant u-velocity panel side edges are to be laid out with user-determined unequal spacings.

Item number 26 is the optional input for the left fin (fin 2). It is included if LVSWP=1 and MSWL>0 in item 18.

Item 26:

YLT(KJ)	distance from fin root chord to the constant u-velocity panel outboard side edge on the left fin, 1 ≤ KJ ≤ MSWL; (MSWL ≤ 19); YLT(1) = 0.0; YLT(MSWL+1) = -B2 of item 19
VSWLEL(KJ)	leading-edge sweep of fin between YLT(KJ-1) and YLT(KJ), negative for sweep back, degrees; 1 ≤ KJ ≤ MSWL+1; VSWLEL(1) = 0.0
VSWTEL(KJ)	trailing-edge sweep of fin between YLT(KJ-1) and YLT(KJ), negative for sweep back, degrees; 1 ≤ KJ ≤ MSWL+1; VSWTEL(1)

This optional input accompanies item 25 and is associated with the left fin or fin 2. The Y spanwise values vary from 0.0 at the root chord in the negative direction to the last value for YLT equal to the negative semispan, -B2.

Item number 27 is the optional input for the upper fin (fin 3). It is included if LVSWP=1 and MSWU>0 in item 18.

Item 27:

ZUT(KJ)	distance from fin root chord to the constant u-velocity panel outboard side edge on the upper fin, 1 ≤ KJ ≤ MSWU+1; (MSWU ≤ 19); ZUT(1) = 0.0; ZUT(MSWU+1) = B2V of item 20
VSWLEU(KJ)	leading-edge sweep of fin between ZUT(KJ-1) and ZUT(KJ), positive for sweep back, degrees; 1 ≤ KJ ≤ MSWU+1; VSWLEU(1) = 0.0
VSWTEU(KJ)	trailing-edge sweep of fin between ZUT(KJ-1) and ZUT(KJ), positive for sweep back, degrees; 1 ≤ KJ ≤ MSWU+1; VSWTEU(1) = 0.0

This information is similar to items 25 and 26. This input should be used for breaks in sweep or unequal spacings. Though the variable ZUT is used to represent the distance from the fin root chord to the outboard constant u-velocity panel edges on the upper fin (fin 3), this variable is used in exactly the same sense as YRT to define the spanwise direction in the plane of the fin.

Item number 28 is the optional input for the lower fin (fin 4). It is included if LVSWP=1 and MSWD>0 in item 18.

Item 28:

ZDT(KJ) distance from fin root chord to the constant u-velocity panel outboard side edge on the lower fin, $1 \leq KJ \leq MSWD+1$; $(MSWD \leq 19)$; ZDT(1) = 0.0; ZDT(MSWD+1) = -B2V of item 20

VSWLED(KJ) leading-edge sweep of fin between ZDT(KJ-1) and ZDT(KJ), negative for sweep back, degrees; $1 \leq KJ \leq MSWD+1$; VSWLED(1) = 0.0

VSWTED(KJ) trailing-edge sweep of fin between ZDT(KJ-1) and ZDT(KJ), negative for sweep back, degrees; $1 \leq KJ \leq MSWD+1$; VSWTED(1) = 0.0

This optional information is similar to items 25 through 26. The variable ZDT again only represents the distance from the fin root chord to the outboard constant u-velocity panel edges in the plane of the lower fin (fin 4). The Z spanwise values vary in the negative direction from 0.0 at the root chord to the last value for ZDT equal to the negative semispan, -B2V.

The next three items of input data, item numbers 29, 30, and 31, are included in the input data deck if a thrust time history is to be specified, NTHRUS=1, in item 4. The input quantities are:

Item 29:

NTPOLY number of polynomials specifying thrust time history; $1 \leq \text{NTPOLY} \leq 5$

Item 30:

TEND(J) final times over which the NTPOLY polynomials apply; J=1,NTPOLY

Item 31:

TC(J,K) coefficients of the polynomials; K=1,6; J=1,NTPOLY

The thrust force as programmed acts along the store longitudina_ axis and is specified by a series of polynomials of the form

$$F_T = \sum_{k=1}^{6} a_k t^{k-1}$$

where F_T is the thrust force in pounds. Up to five polynomials can be used to specify the time history and item 29 contains the number of polynomials, NTPOLY. Item 30 is one card and contains the NTPOLY values of the final time t over which each of the polynomials applies. That is, the first polynomial is used from t = 0 to t = TEND(1), the second from t = TEND(1) to t = TEND(2), and so on. Item 31 is a set of NTPOLY cards which specify the six a_k coefficients, TC(J,K), for the polynomials.

Item number 32 is one card which contains the initial velocities of the store relative to the parent aircraft. The six quantities are:

Item 32:

VXZERO	initial forward velocity of the store parallel to store longitudinal axis, ft/sec
VYZERO	initial lateral velocity of the store perpendicular to store longitudinal axis, ft/sec
VZZERO	initial downward velocity of the store perpendicular to store longitudinal axis, ft/sec
VAR(4)	store initial rolling rate, p, radians/sec
VAR(5)	store initial pitching rate, q, radians/sec
VAR(6)	store initial yawing rate, r, radians/sec

At the beginning of the trajectory, the store is oriented such that its y-axis shown in Figure 17 is parallel to the y_B fuselage axis shown in Figure 5. Thus, the x,z store plane is parallel to the x_B, z_B fuselage plane and the initial vertical translational velocity of the store, VZZERO, is in the x,z store plane perpendicular to the store x-axis. The velocities VXZERO, VYZERO, and VZZERO are positive in the positive x, y, and z directions.

The next card, item number 33, contains three items. They are:

Item 33:

DTIME	integration interval, seconds
TIMEI	initial time, seconds
TIMEF	final time, seconds

The first, DTIME, is the integration interval to be used in the integration subroutine, ADAMS. The version of this routine which is included in the present program does not adjust this interval

to satisfy certain accuracy requirements but uses the input value of DTIME. A value of 0.025 or 0.01 seconds should probably work. However, different values should be tried and the trajectory results compared to determine that a small enough value is being used. Finned stores probably require a smaller value than finless stores because of the large moments produced by the empennage. The initial time, TIMEI, must be input as 0.0 unless a trajectory is to be restarted using the last page of output from a previous run to obtain the initial conditions. Then, TIMEI should be given the value that appears on that page of output. The final time, TIMEF, is the time at which the trajectory calculation is to be terminated. Except for very unusual trajectories, a value of 0.5 to 0.7 second is normally sufficient to determine if a store will or will not clear the aircraft.

If TIMEI and TIMEF are both input as zero, no trajectory calculation will be performed. However, the store load distributions and forces and moments will be calculated with the store in its initial position. This feature can be useful in checking out the entire input data deck prior to running a trajectory or for studying store loads at specific points.

Item number 34, the last item of input, is input only if a trajectory is being restarted, TIMEI $\neq$ 0. This item consists of two cards with VAR(1) through VAR(8) on the first card and VAR(9) through VAR(12) on the second. The following table gives the notation used to identify VAR(1) through VAR(12) on the trajectory program output which will be discussed in Section 4.3.

Program Notation	Output Notation
VAR(1)	DXF, ft/sec
VAR(2)	DYF, ft/sec
VAR(3)	DZF, ft/sec
VAR(4)	P, radians/sec
VAR(5)	Q, radians/sec
VAR(6)	R, radians/sec
VAR(7)	XF of XMOM, ft
VAR(8)	YF of XMOM, ft
VAR(9)	ZF of XMOM, ft
VAR(10)	PSI, degrees
VAR(11)	THETA, degrees
VAR(12)	PHI, degrees

4.2.3 Sample input data

A sample input data deck to the second program will now be presented. It will utilize the wind tunnel model components shown in Figure 9 except that they have been scaled up by a factor of twenty in order to approximate a full-scale aircraft and store. The data will either be input directly in the data deck or indirectly through the calculations performed in Program I and passed through the intermediate dataset. The models were used in the wind tunnel test program described in Reference 11.

The configuration for the sample calculation is shown in Figure 10 as input to the first program. All geometric data for that configuration is input to the first program except that pertaining to the layout of the planar and interdigitated fins. The trajectory calculations start with the store in the carriage position as shown.

The input data deck for the second program is tabulated in Figure 19. The item numbers indicated on the figure correspond to those of Figure 16. The first item of Figure 19 is item number 1

which contains the value of NCARDS, in this case 14. This is followed by item number 2, which consists of these 14 cards of identifying information. It is noted that the tabulated data presented in this sample case and the resulting calculations are intended to simulate the experimental captive store trajectory of Test V6A, Group 363 in Reference 11.

Item number 3 specifies the aircraft flight conditions used in the experimental case. The angle of attack is 5.0°, the flight path angle is 0.0°, and the Mach number is 1.5. The free-stream air density is 0.0005852 slugs per cubic foot, which corresponds to a flight altitude of 40,000 feet. The flight velocity is 1,462 feet per second.

Item 4 contains the ejected store indices. Store number 10, NEJECT=10, is the store being separated. Since the store is modeled using the elliptic body option NSEG and NSORCE are set equal to zero. The parameter, NGAM=1, is set to specify that a captive-store trajectory is to be calculated. No polynomials, NPOLY=0, will be read since it is an elliptic configuration. Though the store is mounted on the centerline, the rolling moment is computed, NROLL=1, to verify the symmetry of the load calculations. The store has two empennages, NEMP=2, corresponding to the two planar fins and the four fins in an interdigitated configuration. No aerodynamic damping will be computed, NDAMP=0, and no thrust time history is to be included, NTHRUS=0. No theta locations are required, NTHETA=0, for the elliptic shape. Ejector force input calculations will be included, NJECTR=1.

Since an ejector is present, the next four items in Figure 19 contain the descriptions of the ejector force versus time history. Item number 5 specifies that one ejector foot is present, NFEET=1, and that it is input as a function of time, NSTRKE=0. The next card, item number 6, specifies that one polynomial will be used to describe the ejector time history, NEPOLY=1, that it is located

one foot aft of the store moment center, XE=1.0, and that it is pointing straight down, THETAE=0°. The stroke over which the force occurs is set to a large number, STROKE=10.0 feet, to allow the force to be terminated when exceeding the final time specified for the polynomial time history, TEEND=0.075 seconds, in item number 7. Item number 8 contains the 5th order polynomial coefficients for the ejector force time history from the following equation from Reference 11:

$$F = 1.41448 \times 10^5 T + 2.68614 \times 10^6 T^2 - 2.2209 \times 10^8 T^3 + 3.52968 \times 10^9 T^4 - 1.70086 \times 10^{10} T^5$$

The next two items contain the mass and inertia characteristics of the separating store. Item number 9 contains the store mass, SMASS=20.0 slugs, moments of inertia, I_{xx}=20., I_{yy}=250., and I_{zz}=250. slug-ft^2, and products of inertia, I_{yz}=0.0, I_{xz}=0.0, and I_{xy}=0.0 slug-ft^2. Item number 10 sets the moment center (XMOM) at 5.0 feet and specifies that there is no center of gravity offset from the moment center.

The next card is item number 13. It contains the axial force coefficient, CA=0.73 obtained from the experimental data.

The next fifteen cards are used to describe the two sets of elliptic store empennages. Item number 16 is used to partition the elliptic store body into body-alone and body-fin sections. The first value, NBOD = 4, indicates that the body is to be split into four sections for load calculations. The variables XBOD(I) and LFIN(I) indicate the length over which the section extends and whether it is finned body section. The first pair, XBOD(1)=5.833 and LFIN(1)=F(false), say that the unfinned body nose extends from the nose at X=0.0 aft to 5.833 feet. The second pair, XBOD(2)=8.333

and LFIN(2)=T(true), indicate that a finned body section extends from 5.833 feet to 8.333 feet. The next unfinned section extends from the forward fin trailing edge at 8.333 to 8.75 feet. The last section is finned and extends from 8.75 to 10.0 feet.

Two sets of item numbers 17 through 24 follow. The first is for the planar fins. It contains the input parameters to describe the fin and interference shell layout. Item number 17 is the descriptive title. For descriptive purposes here the 1st empennage has been designated the "monoplane wing." Item number 18 contains the control indices for the type and number of panels on each fin. The first two values, MSWR = MSWL = 4, place four rows of panels in the spanwise direction on each of the horizontal fins. The next two values are zero indicating no third or fourth fins present. The number of constant u-velocity panels in each chordwise row, NCW = 5, and the number of panels axially on the interference shell, NCWB=5, are set equal to the number of rings of body source panels used to span that region. NBDCR is set to zero to allow the program to use the default values corresponding to the KRADX for the body panels. The last value, LVSWP=0, indicates that there are no planform breaks in sweep and the parameters in item 19 will be used to describe the fins. Item number 19, then, defines the root chord (CRP=2.5 feet), the leading and trailing edge sweeps (SWLEP=53.13° and SWTEP=0°), and the exposed semispan (B2=1.25 feet) for the monoplane wings. Item number 20 is not included since there are only two fins.

Item number 21 states there are no interdigitated angles and that there is no deflection of any of the fins. If the polar angle of the interdigitated tail is zero (THETIT = 0^{o}), the individual angles for each of the wings are read in item number 22. PHIFR = THETR = 0^{o} indicate the right fin is horizontal. PHIFL = THETL = 0^{o} similarly indicate that the second fin is horizontal but to the left. The interference shell body length,

BIL=2.5 feet, in item number 23 is the same as the root chord. The remaining value VRTMAX=0.35 is the recommended default. NVRTIN in item 24 is set to zero for the forward set of fins since no vortices have been computed.

Items numbers 17 through 24 are repeated as before with the geometry for the interdigitated tails given in Figure 9(e). In item number 21 the interdigitated angles (PHIDIH=THETIT=35°) are used to lay out the orientation of all four fins in lieu of inputting each angle in item 22. For the purpose of these calculations NVRTIN is set to 1 in item 24 so that the vortices from the forward empennage do not affect the aft set of fins.

Item number 32 specifies initial axial and lateral translational velocities of the store of 0 feet per second in all directions. This corresponds to the initial condition of the store fixed at the carriage position. Similarly, the initial rotational velocities are all set to 0.0 radians per second.

The last card input in Figure 19, item 33, provides the integration interval and the initial and final times. Since the initial time is 0.0, item 34 is not included.

4.3 Description of Output from Program II

Figure 20 presents the output from Program II for the sample case, the separation of the elliptic store from the configuration in Figure 10.

The first page of output, Figure 20(a), tabulates the input identifying information and the parent aircraft atmospheric flight conditions of item 3. The first eight title lines contain the heading information read in Program I and transferred through the external file. The next 14 lines of title information contain the additional heading information read in Program II which

contain information specific to the present run. The aircraft flight conditions follow.

The information on the next seven pages contains the remaining information describing the separating store, the ejector force, and the resulting layout of the two empennages. In Figure 20(b), the ejected store is identified and the options in input item 4 specified. They are followed by the ejector force history input and polynomials. The additional input specifying the store moments of inertia, mass, center of gravity location, and axial force coefficient are presented next. Following this, the finned body layout output identifies the store body stations which partition the source panels into body alone or empennage sections for force calculation purposes. The first two columns repeat the input of item 16. The last column identifies the x-station index of input item 75 of Program I closest to the input x-station of the first column which will actually be used to partition the body into sections. This is followed by the empennage leading-edge locations of the elliptic store fins.

The third page of output, Figure 20(c), contains the output of the input data describing the first empennage on the elliptic store, designated the monoplane wing. Fin properties are input for only two fins. Of the body properties, only the body interference shell length and its number of streamwise body panels are input at this point in the program. The remaining quantities, the elliptic axes and the number of panels around the body were obtained from the source panel layout from Program I. The interdigitated angles are not used for this layout. The reference area and length are the reference area and diameter defined for the elliptic store body in the first program. The vorticity options are set to allow the program to compute the trailing-edge vorticity off the monoplane wing for integration aft to the second set of surfaces.

The next two pages, Figures 20(d) and 20(e) contain the constant u-velocity panel corner coordinates for the two fins and the interference shell, respectively. These are provided for use in verifying the layout of the panel geometry. The coordinates are in the empennage coordinate system, x_{w_1}, y_{w_1}, z_{w_1}, shown for the first store empennage in Figure 13.

The next three pages, Figures 20(f), 20(g), and 20(h) repeat the input for the second empennage on the elliptic store, designated the interdigitated tail. For this empennage all four fins are input and the interdigitated tail angles are used to specify their orientation. The panel coordinates in the empennage coordinate system, x_{w_2}, y_{w_2}, z_{w_2}, shown in Figure 13 follow.

The last three parts of Figure 20, parts (i), (j), and (k), are output for three points in the trajectory, the first point, an intermediate point, and the point at which the trajectory is terminated. The complete output from the program will contain a page like this for each integration step, in this case every 0.025 seconds.

At the top of each page is the trajectory time in seconds. Following this, the forces and moments, components as well as totals are printed. These are followed by the ejector produced forces and moments. Next, the axial distributions of body-alone normal force and side force are tabulated. These were integrated to determine the "BODY" CN and CY listed at the top of the page. The force and moment calculation is discussed in detail in Section 6 of Reference 1.

The following table relates the program output variables to the x_s, y_s, z_s coordinate system and positive directions shown in Figure 17.

Program Notation	Notation of Figure 17
CN	C_N
CY	C_Y
CLM	C_m
CLN	C_n
CLL	C_ℓ
X,FT	x_s, feet
X/L	x_s/ℓ_s
DCN/DX	dC_N/dx_s, per foot
DCY/DX	dC_Y/dx_s, per foot

As the store pitches, yaws, and rolls during the trajectory, the x_s, y_s, z_s coordinate system pitches, yaws, and rolls with it. The forces are always calculated in this coordinate system.

The remaining quantities tabulated on each page of the trajectory output specify the store location, orientation, velocities, and accelerations relative to the parent aircraft at that particular time. Before discussing these quantities, the coordinate systems must be mentioned. Figure 17 shows another coordinate system, x, y, and z, which is fixed in the store and moves with the store as it yaws, pitches, and rolls. The origin of this system is fixed at the store moment center. This coordinate system is also shown in Figure 21 along with another system, ξ, η, ζ. This latter system is an inertial coordinate system whose origin is fixed in the fuselage nose and is parallel to the x_B, y_B, z_B system of Figure 5. At any given time, the two coordinate systems are orientated with respect to each other by a system of angles. The angles are those shown in Figure 21 and consist of three rotations in the yaw, Ψ, pitch, Θ, and roll, Φ, sequence. The positive senses of the three store rotational velocities about the x,y,z axes are also shown in the figure.

Following the body load distribution output on, for example, Figure 20(i), the location of the store in the fuselage, or inertial, coordinate system is tabulated. The locations of the store nose, NOSE, moment center, XMOM, and base, BASE, are tabulated relative to the fuselage nose and also relative to the position of the store at time t = 0, the initial position. In this tabulation XF is x_B of Figure 5 or ξ of Figure 21. Likewise, YF is y_B or η and ZF is z_B or ζ.

The next output are the translational velocities and accelerations of the store relative to the moving aircraft. For example,

$$\text{DXF} = \frac{dx_B}{dt} \text{ or } \frac{d\xi}{dt}, \text{ ft/sec}$$

$$\text{D2XF} = \frac{d^2x_B}{dt^2} \text{ or } \frac{d^2\xi}{dt^2}, \text{ ft/sec}^2$$

Next the rotational velocities shown in Figure 21 are listed as are the rotational accelerations. The notation is:

$$\text{P} = p, \text{ radians/sec}$$

$$\text{Q} = q, \text{ radians/sec}$$

$$\text{R} = r, \text{ radians/sec}$$

$$\text{PDOT} = \frac{dp}{dt}, \text{ radians/sec}^2$$

$$\text{QDOT} = \frac{dq}{dt}, \text{ radians/sec}^2$$

$$\text{RDOT} = \frac{dr}{dt}, \text{ radians/sec}^2$$

The last output printed at each integration step are the values of the three orientation angles shown in Figure 21 and their time rates of change. The notation is

$$\text{PSI} = \Psi, \text{ deg.}$$

$$\text{THETA} = \Theta, \text{ deg.}$$

$$\text{PHI} = \Phi, \text{ deg.}$$

$$\text{DPSI} = \frac{d\Psi}{dt}, \text{ radians/sec}$$

$$\text{DTHETA} = \frac{d\Theta}{dt}, \text{ radians/sec}$$

$$\text{DPHI} = \frac{d\Phi}{dt}, \text{ radians/sec}$$

4.4 Program Error Messages

The possible occurrence of certain fatal errors and irresolvable conflicts of data during program execution have been anticipated in Program II. If such errors should occur, the program has been designed to print a diagnostic error message and halt when appropriate. Each message with the routine in which the corresponding error is detected is presented in the following table. The program test which resulted in the action is also included. The table is arranged in alphabetical order by the program or subroutine from which it was written.

TRJTRY	STOP 712	Angle of attack and/or Mach number read in does not agree with value from file. (Test: ALFAR $\neq$ ALFACR or CMACH $\neq$ FMACH)

TRJTRY	STOP	normal termination (test: TIME > TIMEF-0.00001 or NDIFEQ = 1)
BDCOEF	message	warning - NAFLD exceeds blank common, **BDCOEF**, NTAP7=__, IUB=__, NAFLD=__. (Test: NAFLD > NADIM)
CRFWBD	STOP 001	(Test: NER > 1; equation solution singular)
INVER2	STOP	**Matrix is singular, INVER2 (Test: A(I,I)=0.0)
NUMACH	STOP	**Axial location of traverse above wing chordal plane, ** NUMACH **. (Test: Z > ZLOC)
NUMACH	STOP 101	(Test: X+BETA*Z+2*CHRD-WLEX+BETA*Z = 0; search for maximum turning angle failing)
SORPAN	STOP 230	** Mach number less than 1, SORPAN (Test: AMACH < 1.)
	STOP 220	Error - body panel slope exceeds Mach angle, J=__, ** SORPAN ** (Test: $1.-BETAL^2*TAND^2<0.$)

If one of the above messages is printed out during program execution, the user should consult the input data first for possible error. The program variable descriptions in Appendices C and D may also be helpful for the meanings of the above test quantities.

4.5 Program II Running Times

The second program described in this report has been run on both the CDC 6600 and CYBER 175 machines. Because of machine differences, the running time varies from one machine to another. As a consequence, only an approximate running time can be given. The second program can be executed multiple times for the single execution of the first program.

The running time for the calculation of the trajectory of the separated store is a function of a number of factors, some of which are:

(a) The number and method used to model the fixed stores, rack and fuselage bodies.

(b) Number of sources and doublets required to represent circular fuselage, rack, or store bodies.

(c) Number of source panels used to represent the noncircular fuselage or elliptic stores.

(d) Number of constant u-velocity panels on the wing, pylon, and elliptic store empennages.

(e) Number of thickness panels on the wing and pylon.

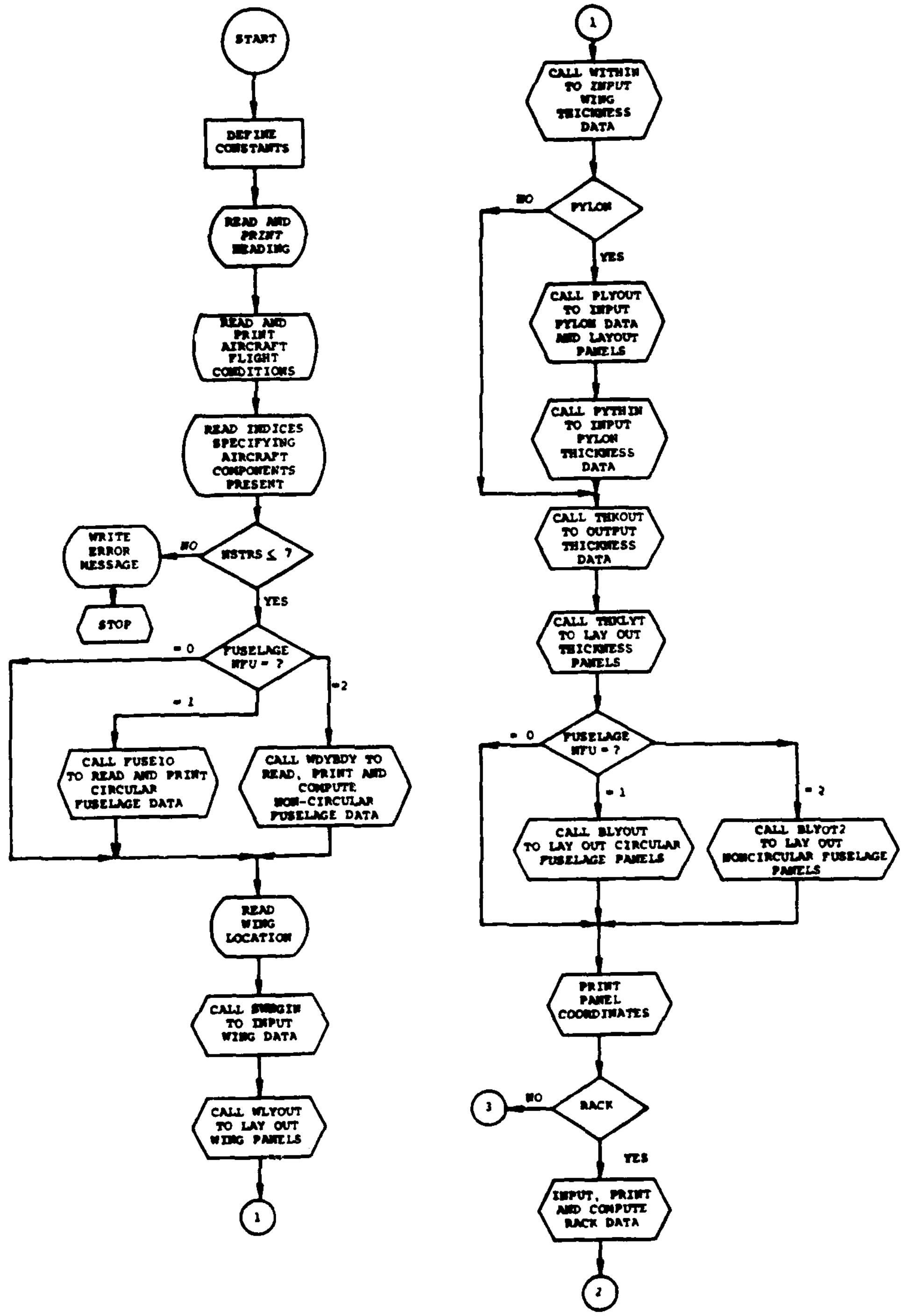
(f) Number of body segments and tail fin control points used in force and moment calculations for the circular store.

(g) Duration interval of separated store in presence of reflected shocks.

(h) Integration interval.

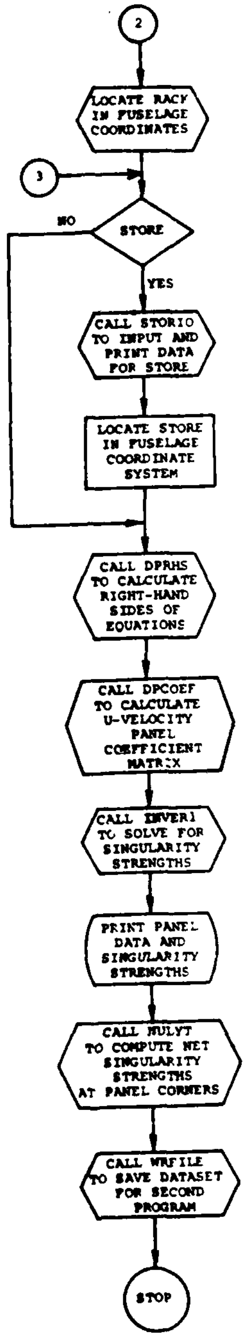
(i) Real time duration of trajectory.

All of the above should be kept to the minimum required to resolve the separated store loads. For the sample case for the second program in Figure 19, the run time was about 1,310 second on the CYBER 175.



(a)

Figure 1.- General flow chart of Program I (LDCALC).



(b)

Figure 1.- Concluded.

Input PROGRAM I - LDCALC

Item No. , (no. of cards), (Omissions), Routine read by:

Item No. 1 (1 card) LDCALC

Variable	NCARDS	
Card Column	1 5	
Format Type	I	

Item No. 2 (NCARDS) LDCALC

Variable	HEAD
Card Column	1 80
Format Type	A

Item No. 3 (1 card) LDCALC

Variable	ALFAC	FMACH	
Card Column	1 10	20	
Format Type	F	F	

Item No. 4 (1 card) LDCALC

Variable	NFU	NPY	NRACK	NSTRS	
Card Column	1 5	10	15	20	
Format Type	I	I	I	I	

If NFU = 0 Omit items 5 thru 33
If NFU ≠ 1, Omit items 5 thru 10
If NFU ≠ 2, Omit items 11 thru 33 FUSEIO

Item No. 5 (1 card. Omit if NFU ≠ 1)

Variable	FLTHC	FRMAX	FTHSHK	
Card Column	1 10	20	30	
Format Type	F	F	F	

Item No. 6 (1 card. Omit if NFU ≠ 1) FUSEIO

Variable	NFPOLY	
Card Column	1 5	
Format Type	I	

(a)

Figure 2.- Program I input formats.

Item No. 7 (1 card. Omit if NFU ≠ 1) FUSEIO

Variable	FXEND(1)	FXEND(2)	...	FXEND(NFPOLY)				
Card Column	1 10	20	30	40	50	60	70	
Format Type	F	F	F	F	F	F	F	

Item No. 8 (NFPOLY cards. Omit if NFU ≠ 1) FUSEIO

Variable	FCOEF(J,1)	FCOEF(J,2)	FCOEF(J,3)	FCOEF(J,4)	FCOEF(J,5)	FCOEF(J,6)	FCOEF(J,7)	
Card Column	1 10	20	30	40	50	60	70	
Format Type	F	F	F	F	F	F	F	

Item No. 9 (1 card. Omit if NFU ≠ 1) FUSEIO

Variable	NCWB	NBDCR1	NBDCR2	NFSOR	
Card Column	1 5	10	15	20	
Format Type	I	I	I	I	

Item No. 10 (1 card. Omit if NFU ≠ 1) FUSEIO

Variable	BODYPL	
Card Column	1 10	
Format Type	F	

Item No. 11 (1 card. Omit if NFU ≠ 2) WDYBDY

Variable	FLTHC	FRMAX	FTHSHK	BODYPL	
Card Column	1 10	20	30	40	
Format Type	F	F	F	F	

Item No. 12 (1 card. Omit if NFU ≠ 2) WDYBDY

Variable	NCWB	
Card Column	1 5	
Format Type	I	

(b)

Figure 2.- Continued.

Omit items 13 through 18 if NFU ≠ 2

Item No. 13 (1 card) — GEOM

Variable	TITLE 1
Card Column	1 ... 80
Format Type	A

Item No. 14 (1 card) — GEOM

Variable	IXZSYM	IPRT(1)	IPRT(2)	IPRT(3)	IPRT(4)	IPRT(5)	IUVW	NSHOCK	MAXSHK	NINLET	NINBLK	NINVEL	IOPTS
Card Column	1 5	10	15	20	25	30	35	40	45	50	55	60	73 80
Format Type	I	I	I	I	I	I	I	I	I	I	I	I	C

Item No. 15 (1 card) — GEOM

Variable	XBIP	XSHLDR	EALPHA		XBIP
Card Column	1 7	14	21		73 80
Format Type	F	F	F		C

Item No. 16 (1 card) — GEOM

Variable	J0	J2	J6	NFUS	NRADX(1)	NFORX(1)	...	NRADX(NFUS)	NFORX(NFUS)	JCARD
Card Column	1 5	10	15	20	25	30	...			73 80
Format Type	I	I	I	I	I	I		I	I	C

Item No. 17 (1 card. Omit if J0 = 0) — CONFIG

Variable	REFA		REFA
Card Column	1 7		73 80
Format Type	F		C

Include K = 1, NFUS sets of items 18 thru 25 as required.

Item No. 18 (NFORX(K) values, 10/card) — CONFIG

Variable	XFUS(1,K)	XFUS(2,K)	...	XFUS(NFORX(K),K)				XFUS
Card Column	1 7	14					70	73 80
Format Type	F	F		F	F	F	F	C

(c)

Figure 2.- Continued.

Omit items 19 through 25 if $NFU \neq 2$

Item No. 19 (NFORX(K) values, 10/card. Omit if J6 = ±1, or J2 = 1)

								CONFIG
Variable	ZFUS(1,K)	ZFUS(2,K)	....	ZFUS(NFORX(K),K)				ZFUS
Card Column	1 7	14					70	73 80
Format Type	F	F		F	F	F	F	C

Include J = 1, NFORX(K) sets of items 20 and 21.

Item No. 20 (NRADX(K) values, 10/card. Include if J2 = 1)

								CONFIG
Variable	Y(1,J,K)	Y(2,J,K)	....	Y(NRADX(K),J,K)				YIJ
Card Column	1 7	14					70	73 80
Format Type	F	F		E	F	F	F	C

Item No. 21 (NRADX(K) values, 10/card. Include if J2 = 1)

								CONFIG
Variable	Z(1,J,K)	Z(2,J,K)	....	Z(NRADX(K),J,K)				ZIJ
Card Column	1 7	14					70	73 80
Format Type	F	F		F	F	F	F	C

Item No. 22 (NFORX(K) values, 10/card. Include if J2 = -1)

								CONFIG
Variable	FUSARD(1,K)	FUSARD(2,K)	....	FUSARD(NFORX(K),K)				FUSARD
Card Column	1 7	14					70	73 80
Format Type	F	F		F	F	F	F	C

Item No. 23 (NFORX(K) values, 10/card. Include if J2 = -2,-3,-5)

								CONFIG
Variable	FUSBY(1,K)	FUSBY(2,K)	....	FUSBY(NFORX(K),K)				FUSBY
Card Column	1 7	14						73 80
Format Type	F	F		F	F	F	F	C

Item No. 24 (NFORX(K) values, 10/card. Include if J2 = -3,-4)

								CONFIG
Variable	FUSAZ(1,K)	FUSAZ(2,K)	....	ERATIO(NFORX(K),K)				A/B
Card Column	1 7	14						73 80
Format Type	F	F		F	F	F	F	C

Item No. 25 (NFORX(K) values, 10/card. Include if J2 = -4,-5)

								CONFIG
Variable	ERATIO(1,K)	ERATIO(2,K)	....	ERATIO(NFORX(K),K)				A/B
Card Column	1 7	14					70	73 80
Format Type	F	F		F	F	F	F	C

(d)

Figure 2.- Continued.

Omit items 26 through 31 if NFU ≠ 2

Item No. 26 (1 card) GEOM

Variable	TITLE 2	
Card Column	1	80
Format Type	A	

Item No. 27 (1 card) GEOM

Variable	KO	KRADX(1)	KFORX(1)	KRADX(2)	KFORX(2)	...	KRADX(NFUS)	KFORX(NFUS)	KCARD
Card Column	1 5	10	15	20	25		50	55	73 80
Format Type	I	I	I	I	I		I	I	C

Item No. 28 (1 + NINLET + NINBLK + NINVEL values, 14/card. Include if NINLET > 0) GEOM

Variable	NIS	JINLT(1)	....	JINLT(NINLET)	....	JINLT(NINBLK)	....	JINLT(NINVEL)	INLETA
Card Column	1 5	10						70	73 80
Format Type	I	I		I					C

Inlet No. 29 (1 card. Include if NINLET > 0) GEOM

Variable	NFINLT		INLETB
Card Column	1 7		73 80
Format Type	F		C

Item No. 30 (1 card. Include if KO = 1) GEOM

Variable	REFAR	REFD	REFL	REFX	REFZ		REFAR
Card Column	1 7	14	21	28	35		73 80
Format Type	F	F	F	F	F		C

Include J = 1, NFUS sets of item 31

Item No. 31 (KRADX(J) values, 10/card. Include if KRADX(J) < 0) GEOM

Variable	PHIK(1,J)	PHIK(2,J)	....	PHIK(KRADX(J),J)					PHIK
Card Column	1 7	14					70		73 80
Format Type	F	F		F	F	F	F		C

(e)

Figure 2.- Continued.

Include $J = 1$, NFUS sets of item 32

Item No. 32 (KFORX(J) values, 10/card. Include if $KFORX(J) > 0$. Omit if NFU $\neq$ 2) GEOM

Variable	XJ(1,J)	XJ(2,J)	...	XJ(KFORX(J),J)				XJ
Card Column	1 7	14					70	73 80
Format Type	F	F		F	F	F	F	C

Item No. 33 (1 card. Omit if NSHOCK $\geq$ 0 Omit if NFU $\neq$ 2) BSHOCK

Variable	PHIS(1)	PHIS(2)	....	PHIS(NSHOCK)				PHIS
Card Column	1 7	14					70	73 80
Format Type	F	F		F	F	F	F	C

Item No. 34 (1 card) LDCALC

Variable	XBWOC	ZBWO	WIC	
Card Column	1 10	20	30	
Format Type	F	F	F	

Item No. 35 (1 card) SWNGIN

Variable	CRW	SSPAN	
Card Column	1 10	20	
Format Type	F	F	

Item No. 36 (1 card) SWNGIN

Variable	NCW	MSW	
Card Column	1 5	10	
Format Type	I	I	

Item No. 37 (I = 1 to MSW + 1; MSW + 1 cards) SWNGIN

Variable	I	Y(I)	PSIWLE(I)	PSIWTE(I)	PHID(I)	
Card Column	1 5	15	25	35	45	
Format Type	I	F	F	F	F	

(f)

Figure 2.- Continued.

Item No. 38 (1 card) SWNGIN

Variable	NTAC	NUNI	
Card Column	1 5	10	
Format Type	I	I	

Item No. 39 (NCW values, eight to a card. Omit if NTAC = 0. One set of cards if NUNI = 1; MSW sets if NUNI = 0.) SWNGIN

Variable	ALPHAL(1)	ALPHAL(2)	...	ALPHAL(NCW)				
Card Column	1 10	20	30	40	50	60	70	80
Format Type	F	F	F	F	F	F	F	F

Item No. 40 (1 card) WITHIN

Variable	NCWS	MSWS	NUNIS	
Card Column	1 5	10	15	
Format Type	I	I	I	

Item No. 41 (I = 1 to MSWS + 1; MSWS + 1 cards) WITHIN

Variable	I	YS(I)	PSWSLE(I)	PSWSTE(I)	PHIS(I)	
Card Column	1 5	15	25	35	45	
Format Type	I	F	F	F	F	

Item No. 42 (NCWS values, eight/card. One set of cards if NUNIS = 1; MSW sets if NUNIS = 0.) WITHIN

Variable	THETAL(1)	THETAL(2)	...	THETAL(NCWS)				
Card Column	1 10	20	30	40	50	60	70	80
Format Type	F	F	F	F	F	F	F	F

Item No. 43 (1 card) Omit if NPY = 0) PLYOUT

Variable	IP	CRP	HP	XPLE	
Card Column	1 5	15	25	35	
Format Type	I	F	F	F	

(g)

Figure 2.- Continued.

Item No. 44 (1 card) (Omit if NPY = 0) PLYOUT

Variable	NCP	MSP
Card Column	1 5	10
Format Type	I	I

Item No. 45 (K = 1, MSP + 1, MSP + 1 card. Omit if NPY = 0) PLYOUT

Variable	K	Z(K)	PSIPLE(K)	PSIPTE(K)
Card Column	1 5	15	25	35
Format Type	I	F	F	F

Item No. 46 (1 card) (Omit if NPY = 0) PYTHIN

Variable	NCPS	MSPS	NUNIP
Card Column	1 5	10	15
Format Type	I	I	I

Item No. 47 Include item 47, I = 1 to MSPS + 1 (MSPS + 1 cards) (Omit if NPY = 0) PYTHIN

Variable	I	ZS(I)	PSPSLE(I)	PSPSTE(I)
Card Column	1 5	15	25	35
Format Type	I	F	F	F

Item No. 48 (NCPS values, eight/card. Omit if NPY = 0. One set of cards if NUNIP = 1; MSPS sets if NUNIP = 0.) PYTHIN

Variable	THETPL(1)	THETPL(2)	...	THETPL(NCPS)				
Card Column	1 10	20	30	40	50	60	70	80
Format Type	F	F	F	F	F	F	F	F

Omit items 49 thru 53 if NRACK = 0

Item No. 49 (1 card) RACKIO

Variable	RLTHC	RRMAX	XRNC	ZRN	RIC
Card Column	1 10	20	30	40	50
Format Type	F	F	F	F	F

(h)

Figure 2.- Continued.

Item No. 50 (1 card) RACKIO

Variable	NRPOLY	
Card Column	1 5	
Format Type	I	

Item No. 51 (1 card) RACKIO

Variable	RXEND(1)	RXEND(2)	...	RXEND(NRPOLY)				
Card Column	1 10	20	30	40	50	60	70	
Format Type	F	F		F	F	F	F	

Include item 52, J = 1 to NRPOLY.

Item No. 52 (NRPOLY cards) RACKIO

Variable	RCOEF(J,1)	RCOEF(J,2)	RCOEF(J,3)	RCOEF(J,4)	RCOEF(J,5)	RCOEF(J,6)	RCOEF(J,7)	
Card Column	1 10	20	30	40	50	60	70	
Format Type	F	F	F	F	F	F	F	

Item No. 53 (1 card) RACKIO

Variable	NRSOR	RTHSHK	
Card Column	1 5	15	
Format Type	I	F	

Item No. 54 (J = 1 to NSTRS; NSTRS cards) STORIO

Variable	NUMSTR(J)	NSHAPE(J)	SLTHC(J)	SRMAX(J)	XSNC(J)	YSN(J)	ZSN(J)	SIC(J)	SPHIR(J)
Card Column	1 5	10	20	30	40	50	60	70	80
Format Type	I	I	F	F	F	F	F	F	F

Item No. 55 (1 card) STORIO

Variable	NSHPT	
Card Column	1 5	
Format Type	I	

(i)

Figure 2.- Continued.

Include NSHPT sets of items 56 thru 76
as required for each store shape.

Item No. 56 (1 card) STORIO

Variable	MSHAPE(J)	MSOR	STHSHK	
Card Column	1 5	10	20	
Format Type	I	I	F	

Item No. 57 (1 card. Omit if MSHAPE(J) > 50) STORIO

Variable	NSPOLJ	
Card Column	1 5	
Format Type		

Item No. 58 (1 card. Omit if MSHAPE(J) > 50) STORIO

Variable	SXNDJ(1)	SXNDJ(2)	....	SXNDJ(NSPOLJ)				
Card Column	1 10	20			50	60	70	
Format Type	F	F	F	F	F	F	F	

Item No. 59 (NSPOLJ cards; K = 1 to NSPOLJ. Omit if MSHAPE(J) > 50) STORIO

Variable	SCOFJ(K,1)	SCOFJ(K,2)	SCOFJ(K,3)	SCOFJ(K,4)	SCOFJ(K,5)	SCOFJ(K,6)	SCOFJ(K,7)	
Card Column	1 10	20	30	40	50	60	70	
Format Type	F	F	F	F	F	F	F	

Omit items 60 thru 76 if MSHAPE(J) ≤ 50)

Item No. 60 (1 card) GEOM

Variable	TITLE 1
Card Column	1 80
Format Type	A

(j)

Figure 2.- Continued.

Item No. 61 (1 card)

Variable	IXZSYM	IPRT(1)	IPRT(2)	IPRT(3)	IPRT(4)	IPRT(5)	IUVW	NSHOCK	MAXSHK	NINLET	NINBLK	NINVEL		IOPTS
Card Column	1 5	10	15	20	25	30	35	40	45	50	55	60		73 80
Format Type														C

Item No. 62 (1 card)

								GEOM
Variable	XBIP	XSHLDR	EALPHA					XBIP
Card Column	1 7	14	21					73 80
Format Type	F	F	F					C

Item No. 63 (1 card)

Variable	J0	J2	J6	NFUS	NRADX	NFORX		JCARD
Card Column	1 5	10	15	20	25	30		73 80
Format Type								

Item No. 64 (1 card) (Omit if J0 = 0)

			CONFIG
Variable	REFA		REFA
Card Column	1 7		73 80
Format Type	F		C

Item No. 65 (NFORX values, 10/card)

									CONFIG
Variable	XFUS(1)	XFUS(2)	....	XFUS(NFORX)					XFUS
Card Column	1 7	14				63	70		73 80
Format Type	F	F		F	F	F	F		C

Item No. 66 (NFORX values, 10/card, Omit if J6 = ±1)

									CONFIG
Variable	ZFUS(1)	ZFUS(2)	....	ZFUS(NFORX)					ZFUS
Card Column	1 7	14					70		73 80
Format Type	F	F		F	F	F	F		C

(k)

Figure 2.- Continued.

Item No. 67 (NFORX values, 10/card. Include if J2 = -1)

								CONFIG
Variable	FUSARD(1)	FUSARD(2)	....	FUSARD(NFORX)				FUSARD
Card Column	1 7	14				63	70	73 80
Format Type	F	F		F	F	F	F	C

Item No. 68 (NFORX values, 10/card. Include if J2 = -2,-3,-5)

								CONFIG
Variable	FUSBY(1)	FUSBY(2)	....	FUSBY(NFORX)				FUSBY
Card Column	1 7	14				63	70	73 80
Format Type	F	F		F	F	F	F	C

Item No. 69 (NFORX values, 10/card. Include if J2 = -3,-4)

								CONFIG
Variable	FUSAZ(1)	FUSAZ(2)	....	FUSAZ(NFORX)				FUSAZ
Card Column	1 7	14				63	70	73 80
Format Type	F	F		F	F	F	F	C

Item No. 70 (NFORX values, 10/card. Include if J2 = -4,-5)

								CONFIG
Variable	ERATIO(1)	ERATIO(2)	....	ERATIO(NFORX)				A/B
Card Column	1 7	14				63	70	73 80
Format Type	F	F		F	F	F	F	C

Item No. 71 (1 card)

	GEOM
Variable	TITLE 2
Card Column	1 80
Format Type	A

Item No. 72 (1 card)

					GEOM
Variable	KO	KRADX	KFORX		KCARD
Card Column	1 5	10	15		73 80
Format Type	I	I	I		C

(1)

Figure 2.- Continued.

Item No. 73 (1 card. Include if KO = 1)

							GEOM
Variable	REFAR	REFD	REFL	REFX	REFZ		REFAR
Card Column	1 7	14	21	28	35		73 80
Format Type	F	F	F	F	F		C

Item No. 74 (KRADX values, 10/card. Include if KRADX < 0

								GEOM
Variable	PHIK(1)	PHIK(2)	....	PHIK(KRADX)				PHIK
Card Column	1 7	14					70	73 80
Format Type	F	F		F	F	F	F	C

Item No. 75 (KFORX values, 10/card. Include if KFORX > 0)

								GEOM
Variable	XJ(1)	XJ(2)	....	XJ(KFORX)				XJ
Card Column	1 7	14					70	73 80
Format Type	F	F		F	F	F	F	C

Item No. 76 (Up to two cards. Include 1 card for every shape with MSHAPE(ISHP) > 50 and NSHOCK(ISHP) < 0)

								BSHOCK
Variable	PHIS(1)	PHIS(2)	....	PHIS(NSHOCK)				PHIS
Card Column	1 7	14					70	73 80
Format Type	F	F		F	F	F	F	C

This concludes the input to program 1.

(m)

Figure 2.- Concluded.

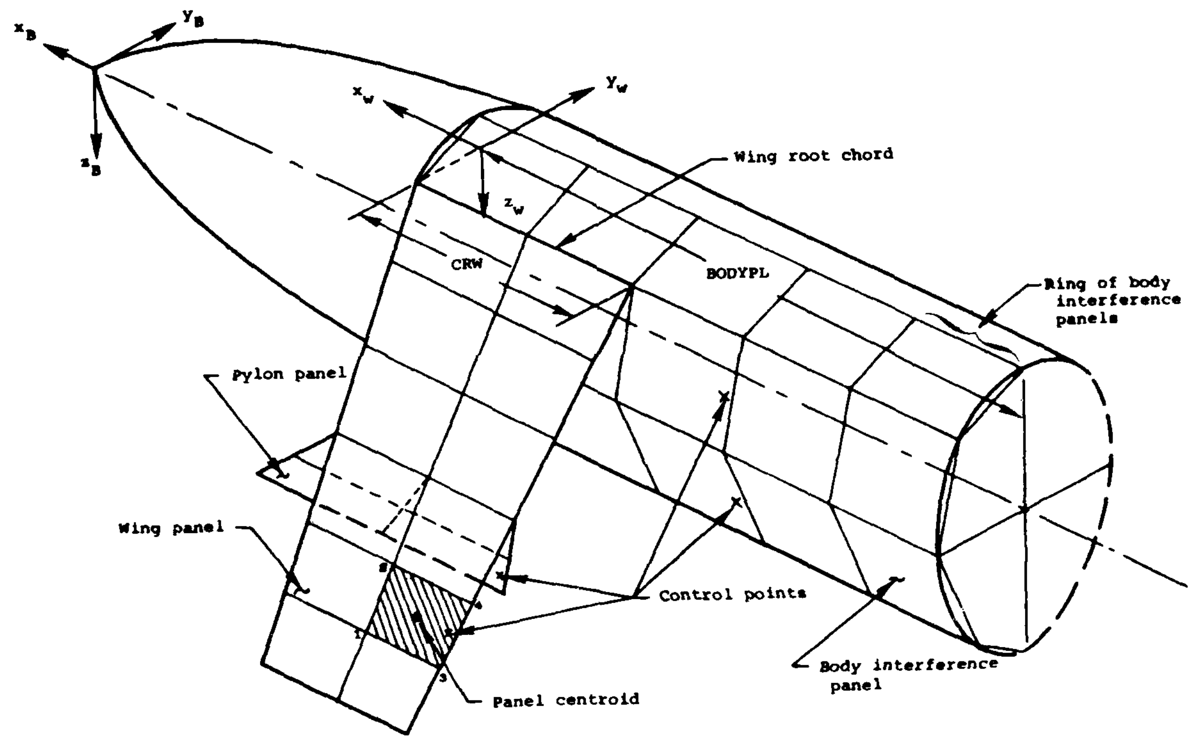


Figure 3.- Simplified layout of panels for wing-pylon and fuselage combination.

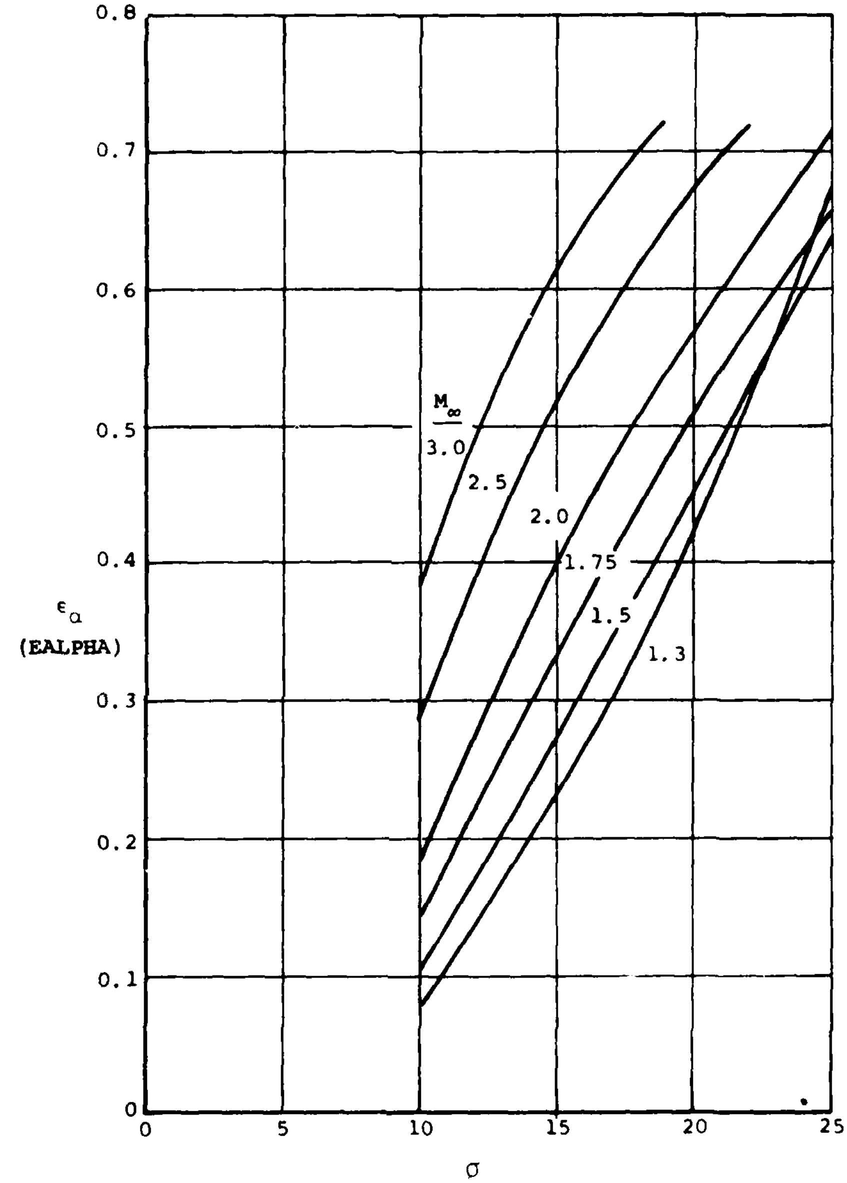


Figure 4.- Shock angle of attack correction factor, ϵ_α.

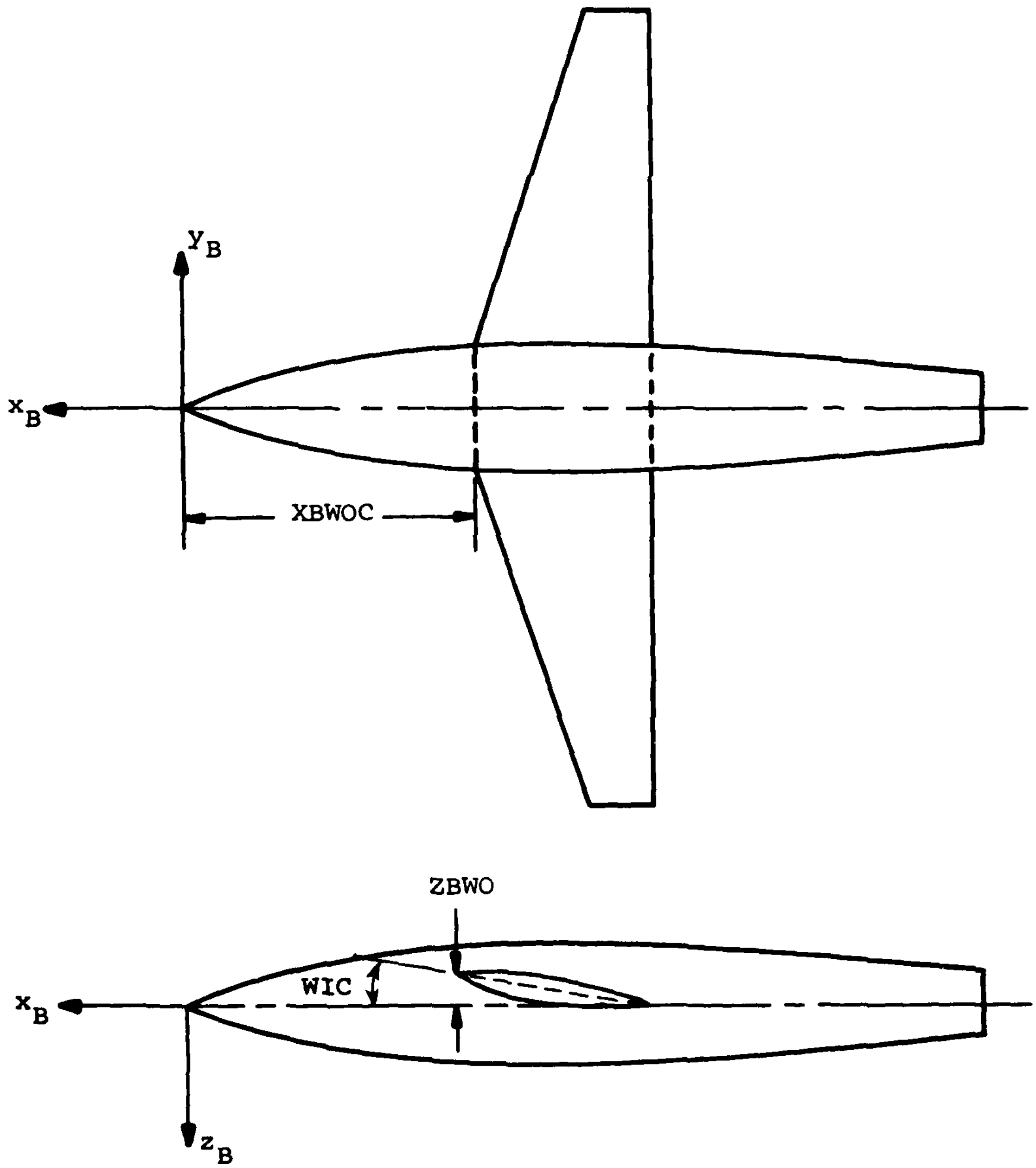


Figure 5.- Fuselage coordinate system.

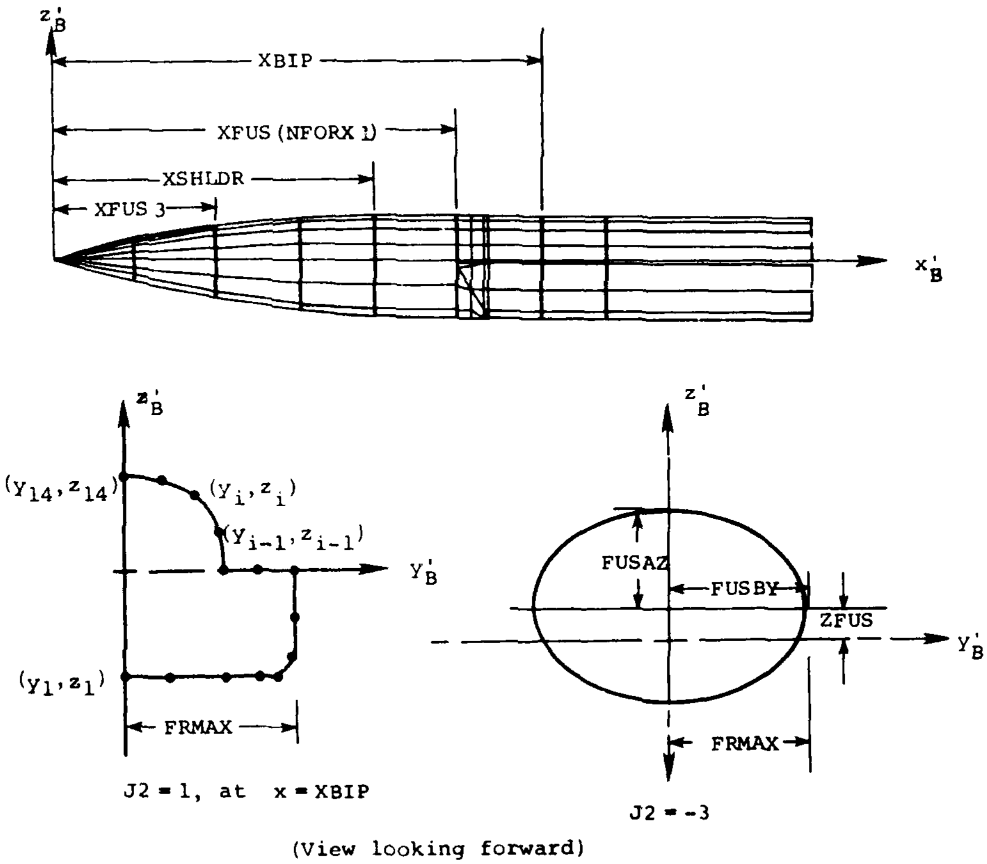
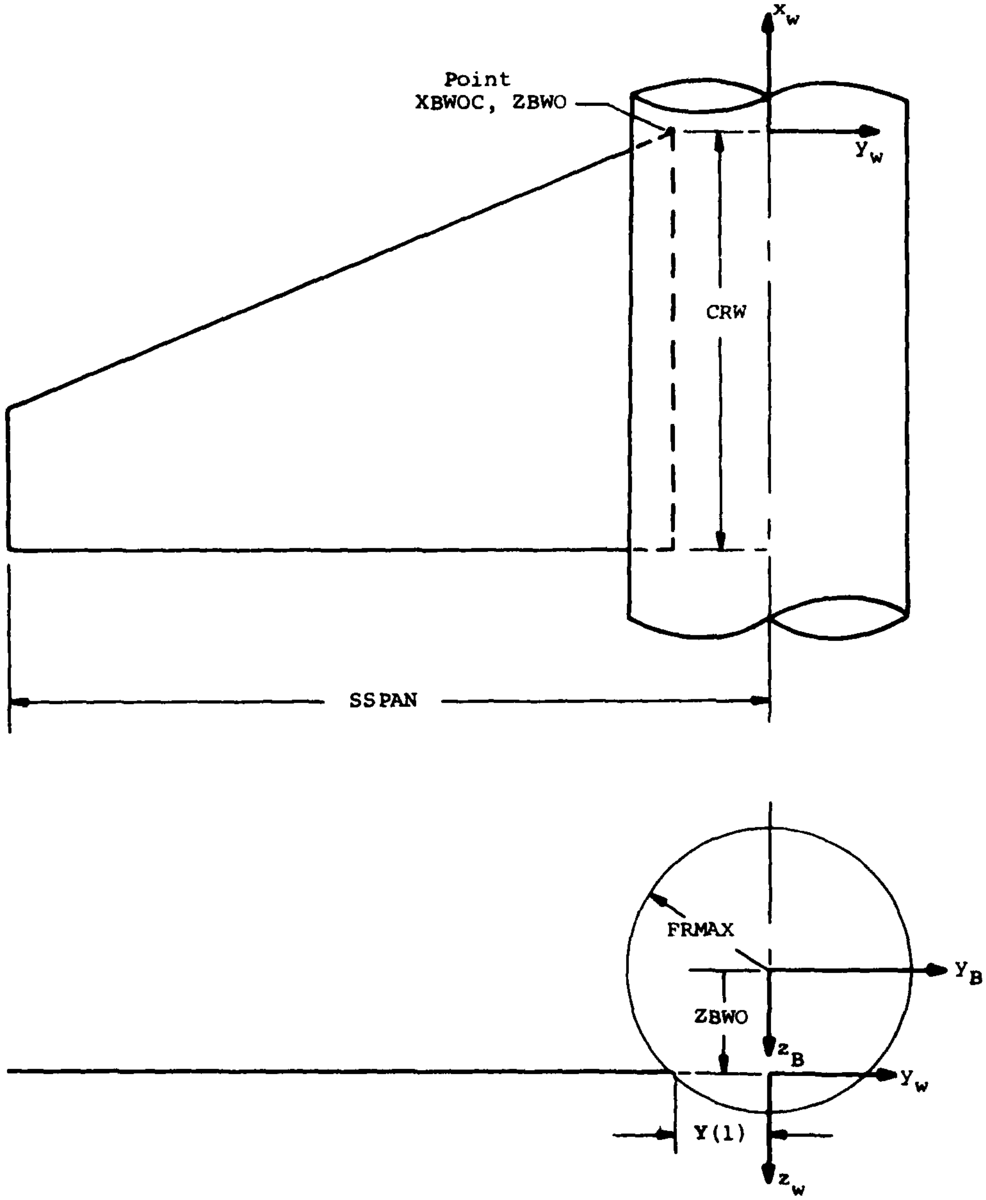
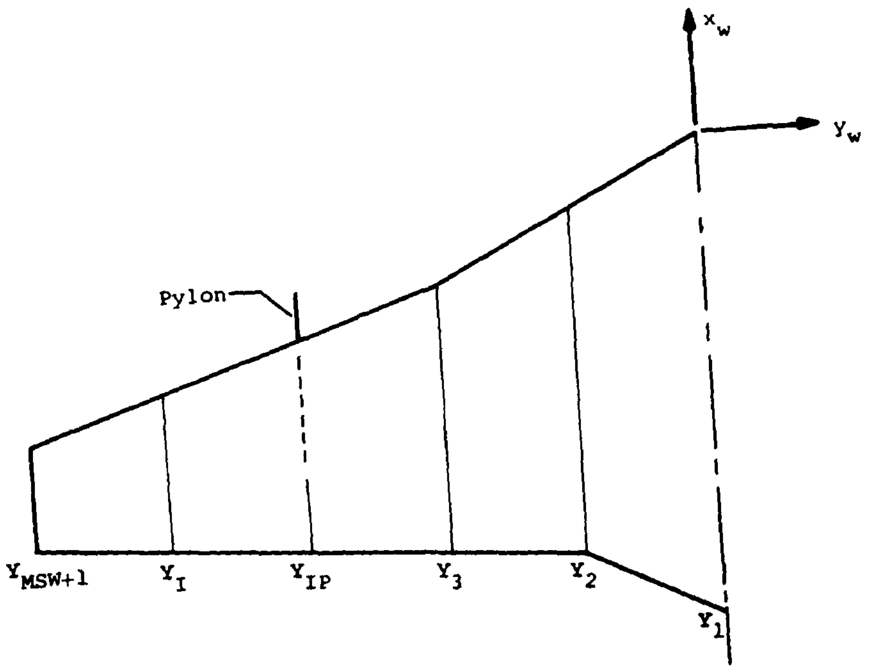


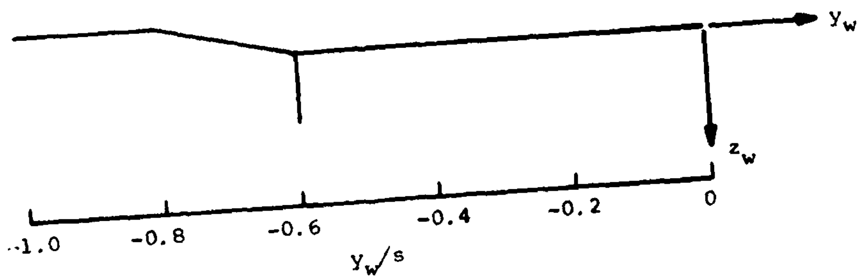
Figure 6.- Fuselage source panel coordinate system.



(a) Definition of certain variables

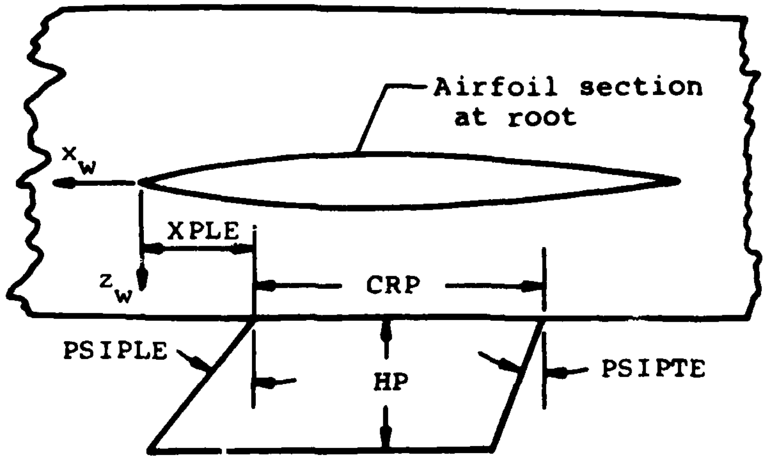
Figure 7.- Wing input variables.



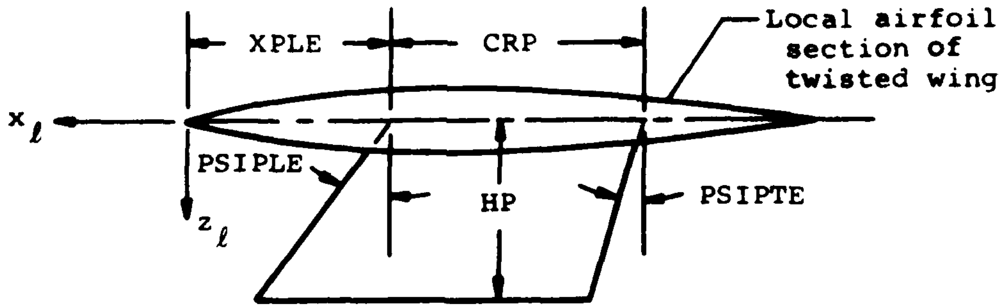


(b) Example wing.

Figure 7.- Concluded.

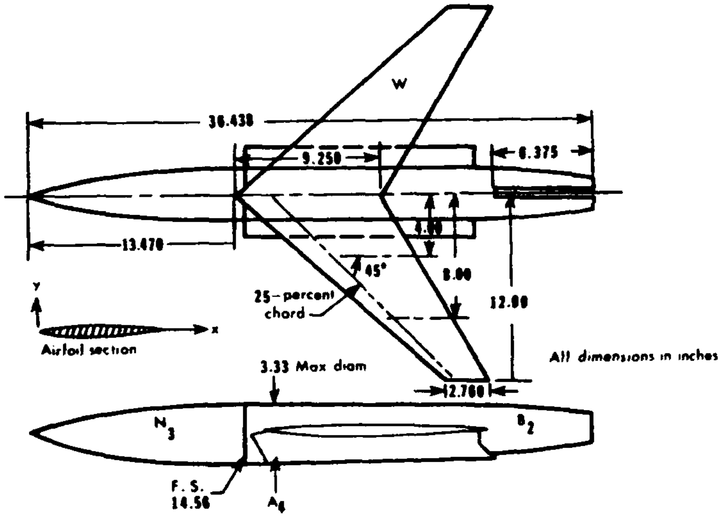


(a) Pylon under fuselage centerline.



(b) Pylon under wing.

Figure 8.- Variables describing and locating pylon, input data item number 43.

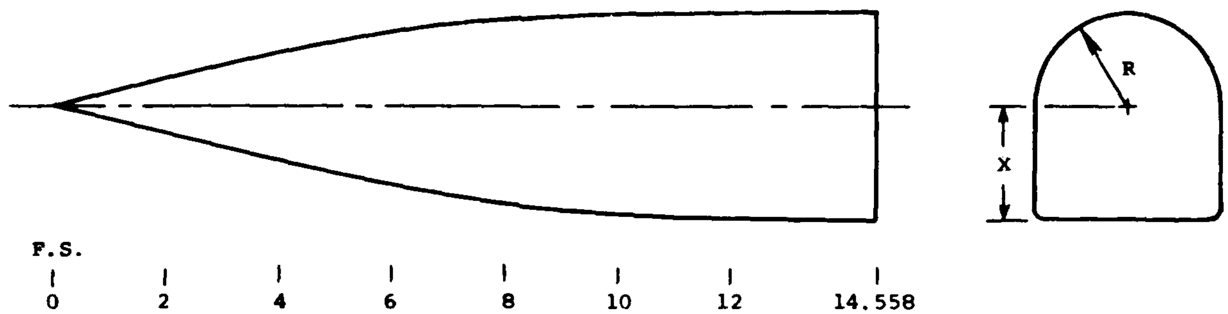


NACA 65A006
Airfoil Coordinates

X, % Chord See Sec.	Y, % Chord See Sec.
0.00	0.000
0.50	0.464
0.75	0.563
1.25	0.718
2.50	0.981
5.00	1.313
7.50	1.591
10.00	1.824
15.00	2.194
20.00	2.474
25.00	2.687
30.00	2.842
35.00	2.945
40.00	2.996
45.00	2.992
50.00	2.925
55.00	2.793
60.00	2.602
65.00	2.364
70.00	2.087
75.00	1.775
80.00	1.437
85.00	1.083
90.00	0.727
95.00	0.370
100.00	0.813
L.E. Radius 0.228% Chd.	
T.E. Radius 0.014% Chd.	

(a) Configuration $N_3B_2A_4$

Figure 9.- Wind-tunnel models.

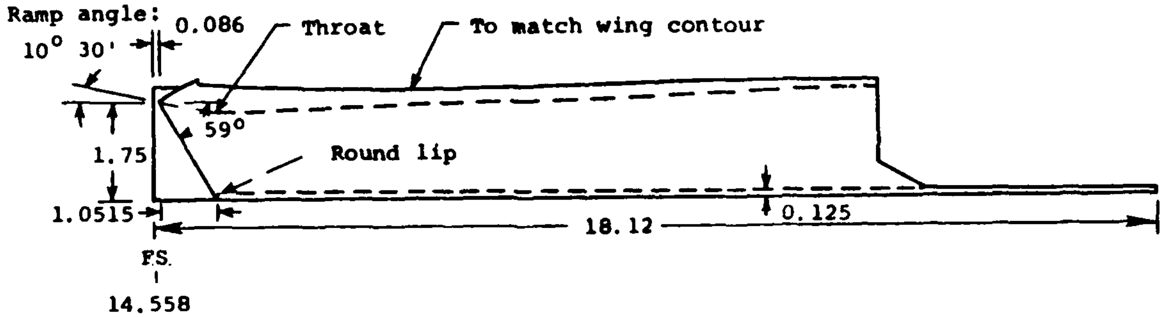


F.S.	R	X
0	0	0
1.0	0.25	0.25
2.4	0.623	0.639
3.0	0.75	0.778
3.6	0.878	0.921
4.0	0.955	1.009
4.5	1.045	1.114
5.0	1.129	1.214
6.0	1.275	1.395
6.5	1.348	1.488
7.0	1.404	1.581
8.0	1.504	1.702
8.4	1.534	1.747
9.0	1.580	1.817
9.6	1.614	1.874
10.0	1.632	1.908
10.8	1.651	1.955
11.66	1.665	2.000

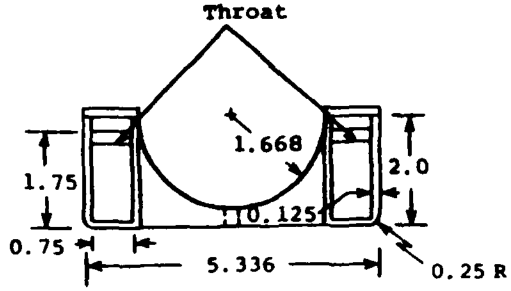
All dimensions in inches

(b) Noncircular nose, N_3

Figure 9.- Continued.



(a) Side view.

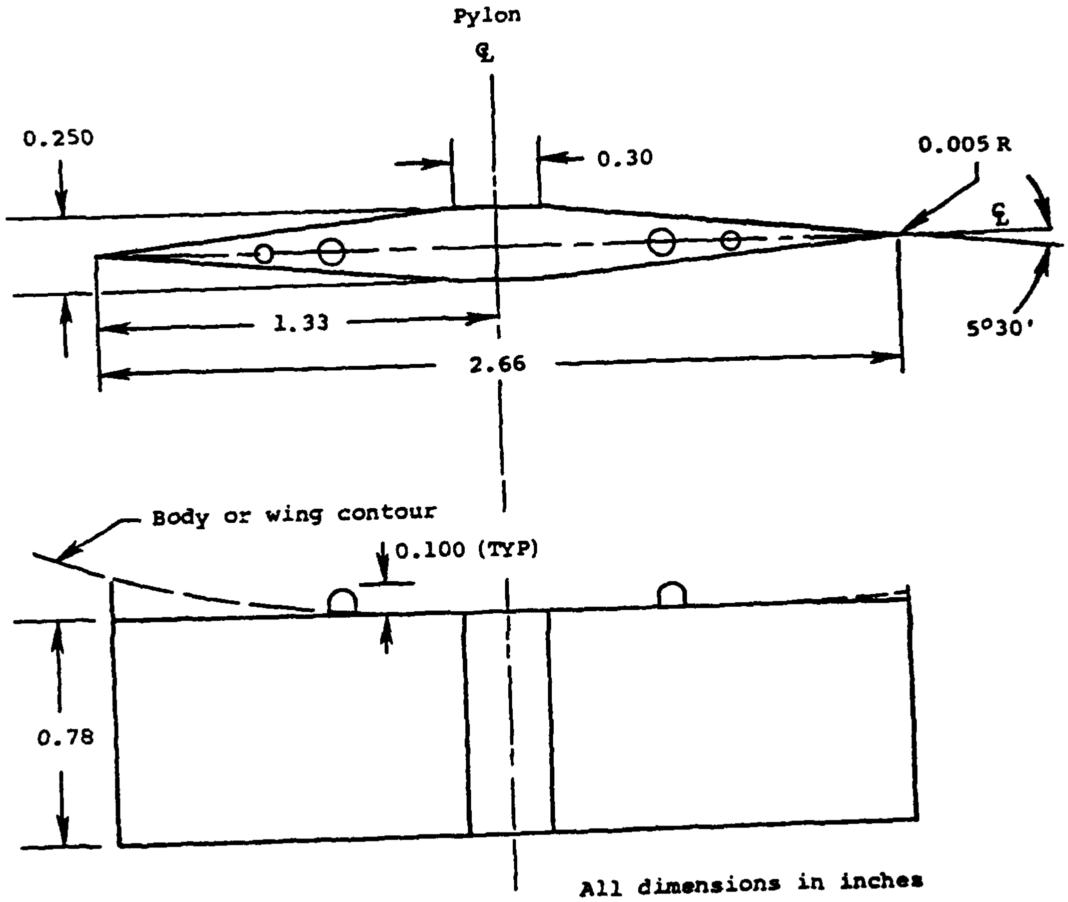


All dimensions in inches

(b) Front view.

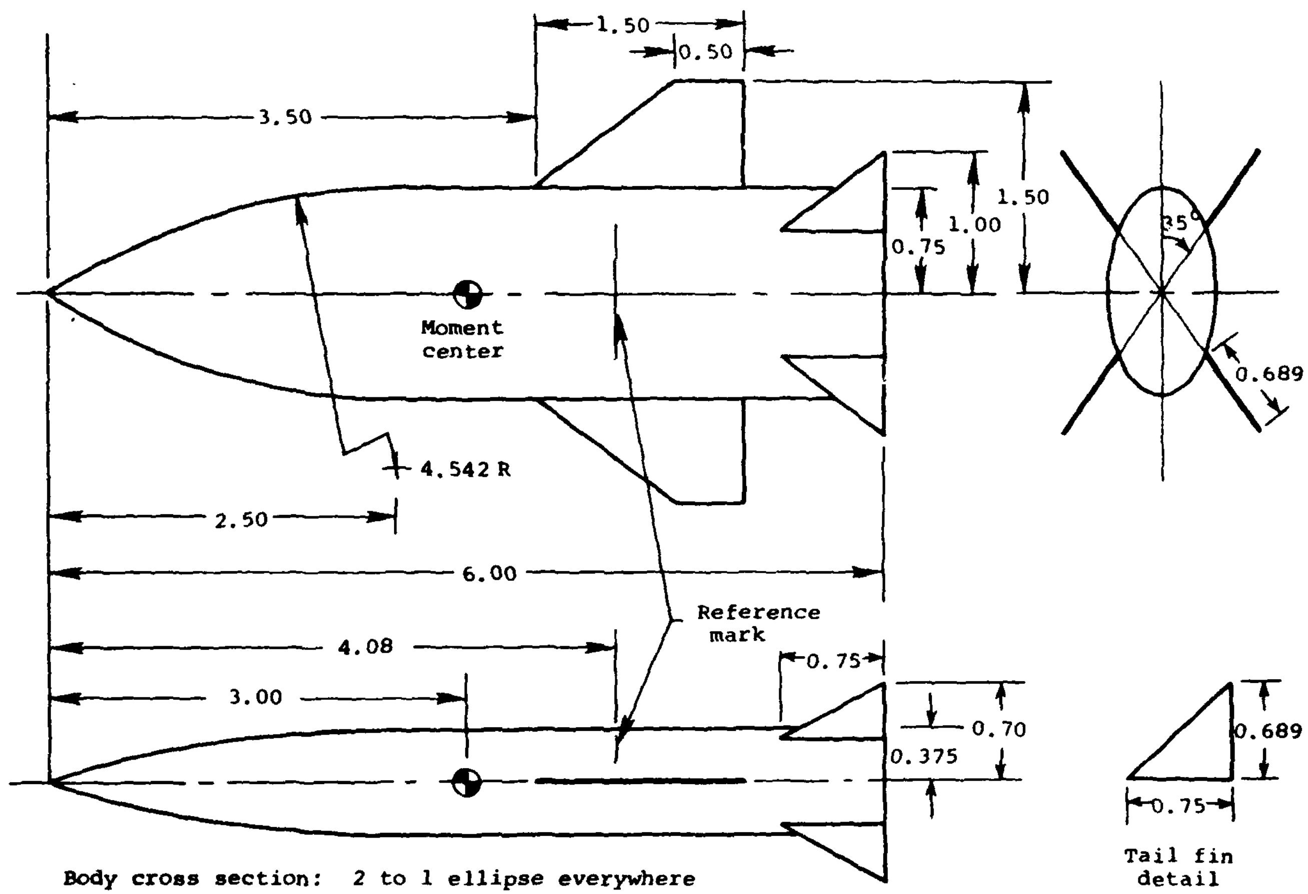
(c) Duct assembly for $M_\infty = 1.5$, A_4

Figure 9.- Continued.



(d) Pylon, $(P2)_C$

Figure 9.- Continued.



Body cross section: *2 to 1 ellipse everywhere*
Wing leading and tailing edges: *Double wedge*
Tail fin leading edge: Double wedge

(e) Elliptic store model, S_E

Figure 9.- Concluded.

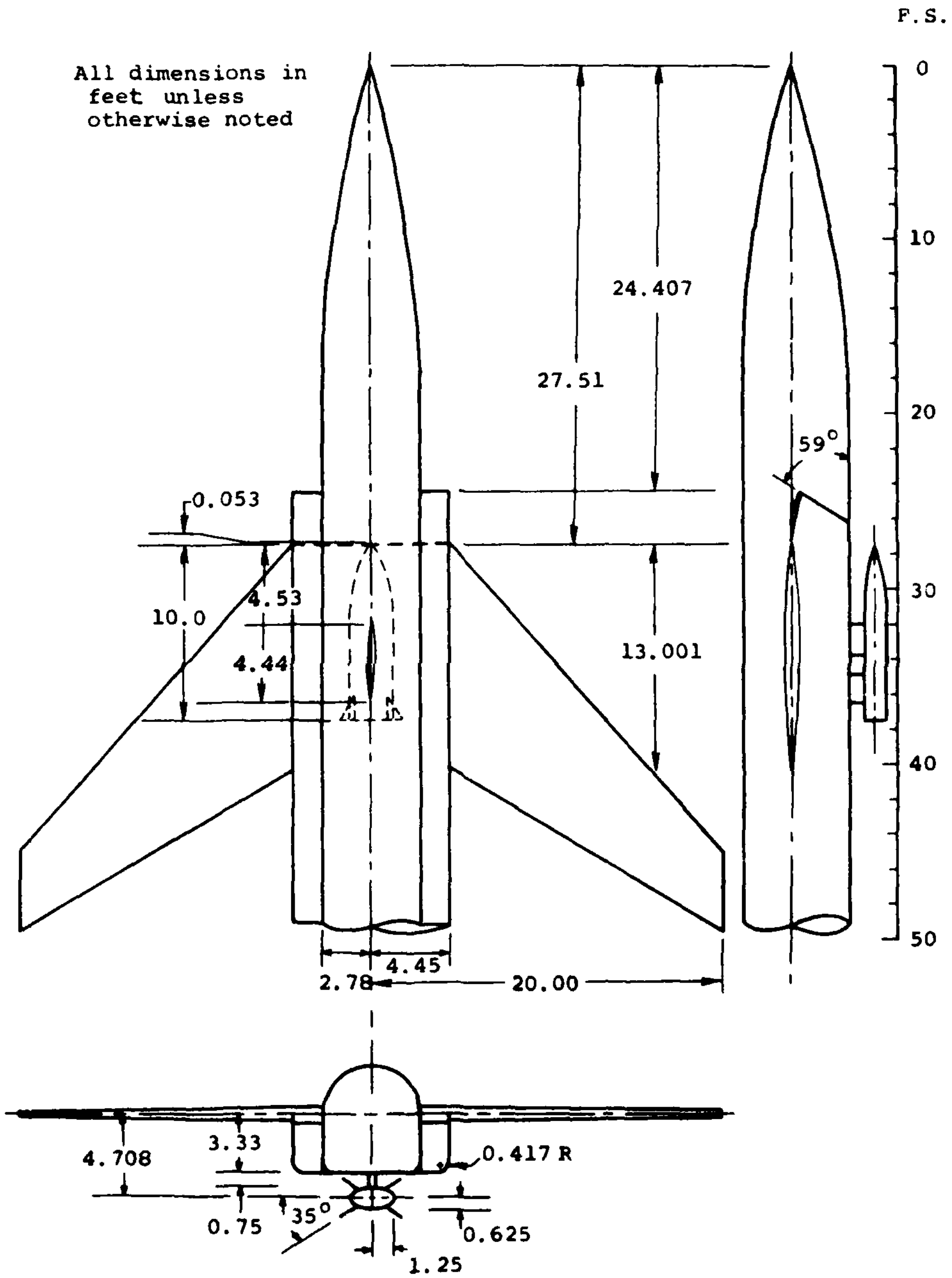


Figure 10.- Configuration used in sample calculation.

```
                                                                          Item No.
     [illegible]                                                                 1
   WIND TUNNEL MODEL                                                             2
     AIRCRAFT AND STORE ARE SCALED UP VERSIONS OF MODELS USED IN EXPERIMENTAL
           PROGRAM CONDUCTED IN CONJUNCTION WITH THIS WORK
     MODELS SCALED UP BY A FACTOR OF 20 TO APPROPRIATE FULL SCALE AIRCRAFT
     PARENT CONFIGURATION N3-R2----A4-(P2)C
     MACH NUMBER = 1.5
     ANGLE OF ATTACK =  5.0 DEGREES
     2 TO 1 ELLIPTIC STORE MODEL - SF
5.0          1.5                                                                 3
   2    1    0    1                                                              4
60.85     4.45      45.8      13.001                                            11
   [illegible]                                                                  12
     NONCIRCULAR FUSELAGE MODEL  -  N3-R2-A4                                    13
   0    1    1    1    0    1    1    3    8    4    2   19          INPTS      14
28.0    0.0    0.315                                                XRIP       15
   0    1   -1    5   10   19   16    2   16    2   15    2   14   2 JCARD     16
0.0     1.667  4.0     5.0     6.0     6.667  7.5    8.333  10.0   10.833  XFUS10  18
11.667 13.333 14.0    15.0    16.0    16.667 18.0   19.433 24.407          XFUS19
0.0     0.0    0.0     0.0     0.0     0.0    0.0    0.0    0.0    0.0   Y-N3R2-A4 20
0.0     0.0    0.0     0.0     0.0     0.0    0.0    0.0    0.0    0.0   Z-N3R2-A4 21
 0.0000  .1289  .2451  .3374  .3966  .4170  .3853  .2949  .1596 0.0000 Y-N3R2-A4 20
-.4170 -.3966 -.3374 -.2451 -.1289  .0000  .1596  .2949  .3853  .4170 Z-N3R2-A4 21
 0.0000  .6210  .9159 1.0380 1.0380 1.0380  .9590  .7340  .3972 0.0000 Y-N3R2-A4  :
-1.0650-1.0650 -.9429 -.6480 -.3240  .0000  .3972  .7340  .9590 1.0380 Z-N3R2-A4  :
 0.0000  .4165  .8330 1.2500 1.2500 1.2500 1.1548  .8839  .4784 0.0000 Y-N3R2-A4
-1.2970-1.2970-1.2970 -.6800 -.4400  .0000  .4784  .8839 1.1548 1.2500 Z-N3R2-A4
 0.0000  .5230 1.0460 1.4630 1.4630 1.4630 1.3516 1.0345  .5599 0.0000 Y-N3R2-A4
-1.5350-1.5350-1.5350-1.1180 -.5590  .0000  .5599 1.0345 1.3516 1.4630 Z-N3R2-A4
 0.0000  .5875 1.1750 1.5920 1.5920 1.5920 1.4708 1.1257  .6092 0.0000 Y-N3R2-A4
-1.6820-1.6820-1.6820-1.2050 -.6325  .0000  .6092 1.1257 1.4708 1.5920 Z-N3R2-A4
 0.0000  .6625 1.3250 1.7420 1.7420 1.7420 1.6094 1.2318  .6666 0.0000 Y-N3R2-A4
-1.8570-1.8570-1.8570-1.4400 -.7200  .0000  .6666 1.2318 1.6094 1.7420 Z-N3R2-A4
 0.0000  .7325 1.4650 1.8820 1.8820 1.8820 1.7387 1.3308  .7202 0.0000 Y-N3R2-A4
-2.023 -2.023 -2.023 -1.606  -.8032  .0000  .7202 1.3308 1.7387 1.8820 Z-N3R2-A4
 0.0000  .8540 1.7080 2.1250 2.1250 2.1250 1.9632 1.5026  .8132 0.0000 Y-N3R2-A4
-2.3250-2.3250-2.3250-1.9080 -.9540  .0000  .8132 1.5026 1.9632 2.1250 Z-N3R2-A4
 0.0000  .9150 1.8300 2.2470 2.2470 2.2470 2.0760 1.5889  .8599 0.0000 Y-N3R2-A4
-2.480 -2.480 -2.480 -2.063 -1.0315  .0000  .8599 1.5889 2.0760 2.2470 Z-N3R2-A4
 0.0000  .9615 1.9230 2.3400 2.3400 2.3400 2.1619 1.6546  .8955 0.0000 Y-N3R2-A4
-2.6350-2.6350-2.6350-2.2180-1.1090  .0000  .8955 1.6546 2.1619 2.3400 Z-N3R2-A4
 0.0000 1.0450 2.0900 2.5070 2.5070 2.5070 2.3162 1.7727  .9594 0.0000 Y-N3R2-A4
-2.8370-2.8370-2.8370-2.4200-1.2100  .0000  .9594 1.7727 2.3162 2.5070 Z-N3R2-A4
 0.0000 1.0700 2.1400 2.5570 2.5570 2.5570 2.3624 1.8081  .9785 0.0000 Y-N3R2-A4
-2.9120-2.9120-2.9120-2.4950-1.2475  .0000  .9785 1.8081 2.3624 2.5570 Z-N3R2-A4
 0.0000 1.1080 2.2160 2.6330 2.6330 2.6330 2.4326 1.8618 1.0076 0.0000 Y-N3R2-A4
-3.0280-3.0280-3.0280-2.611 -1.306   .0000 1.0076 1.8618 2.4326 2.6330 Z-N3R2-A4
 0.0000 1.1365 2.2730 2.6900 2.6900 2.6900 2.4852 1.9021 1.0294 0.0000 Y-N3R2-A4
-3.1230-3.1230-3.1230-2.7060-1.3530  .0000 1.0294 1.9021 2.4852 2.6900 Z-N3R2-A4
 0.0000 1.1515 2.3030 2.7200 2.7200 2.7200 2.5130 1.9233 1.0409 0.0000 Y-N3R2-A4
-3.1800-3.1800-3.1800-2.7630-1.3815  .0000 1.0409 1.9233 2.5130 2.7200 Z-N3R2-A4
 0.0000 1.1675 2.3350 2.7520 2.7520 2.7520 2.5425 1.9460 1.0531 0.0000 Y-N3R2-A4
-3.2580-3.2580-3.2580-2.8410-1.4205  .0000 1.0531 1.9460 2.5425 2.7520 Z-N3R2-A4
 0.0000 1.1790 2.3580 2.7750 2.7750 2.7750 2.5638 1.9622 1.0619 0.0000 Y-N3R2-A4
-3.3330-3.3330-3.3330-2.9160-1.4580  .0000 1.0619 1.9622 2.5638 2.7750 Z-N3R2-A4
 0.0000 1.1790 2.3580 2.7750 2.7750 2.7750 2.5638 1.9622 1.0619 0.0000 Y-N3R2-A4 20
-3.3330-3.3330-3.3330-2.9160-1.4580  .0000 1.0619 1.9622 2.5638 2.7750 Z-N3R2-A4 21
24.667 25.191                                                          XFUSR2    18
 0.0000 1.1790 2.3580 2.7750 2.7750 2.7750 3.610  4.447  4.447  3.610  Y-N3R2-A4 20
 2.7750 2.7750 2.5638 1.9622 1.0619 0.0000                             Y-N3R2-A4 21
```

Segment 1

(a)

Figure 11.- Input data deck for sample case for Program I.

```
-3.3330-3.3330-3.3330-2.9160-1.4580 -.4167 -.4167 -.4167 -.4167 -.4167 Z-N3B2-44
-.4167 0.0    1.0619 1.9622 2.5638 2.7750                               Z-N3B2-44
 0.0000 1.1790 2.3580 2.7750 2.7750 2.7750 3.610  4.447  4.447  3.610   Y-N3B2-44
 2.7750 2.7750 2.5638 1.9622 1.0619 0.0000                              Y-N3B2-44
-3.3330-3.3330-3.3330-2.9160-1.667 -1.667 -1.667 -1.667 -0.2    -0.2    Z-N3B2-44
-0.2    0.0    1.0619 1.9622 2.5638 2.7750                              Z-N3B2-44
25.101 25.9422                                                          XFUS02     18
 0.0000 1.1790 2.3580 2.7750 2.7750 3.610  4.447  4.447  4.447  3.610   Y-N3B2-44  20
 2.7750 2.7750 2.5638 1.9622 1.0619 0.0000                              Y-N3B2-44  21
-3.3330-3.3330-3.3330-2.9160-1.667 -1.667 -1.667 -1.667 -0.2    -0.2    Z-N3B2-44
-0.2    0.0    1.0619 1.9622 2.5638 2.7750                              Z-N3B2-44
 0.0000 1.1790 2.7750 2.7750 2.7750 3.610  4.447  4.447  4.447  3.610   Y-N3B2-44
 2.7750 2.7750 2.5638 1.9622 1.0619 0.0000                              Y-N3B2-44
-3.3330-3.3330-3.3330-3.3330-2.9160-2.9160-2.9160-1.667 0.0     0.0     Z-N3B2-44
0.0    0.0    1.0619 1.9622 2.5638 2.7750                               Z-N3B2-44
25.942226.1925                                                          XFUS02     18
 0.0000 1.1790 2.7750 2.7750 3.610  4.447  4.447  4.447  4.447  3.610   Y-N3B2-44  20
 2.7750 2.5638 1.9622 1.0619 0.0000                                     Y-N3B2-44  21
-3.3330-3.3330-3.3330-2.9160-2.9160-2.9160-2.9160-1.667 0.0     0.0     Z-N3B2-44
0.0    1.0619 1.9622 2.5638 2.7750                                      Z-N3B2-44
 0.0000 1.1790 2.7750 2.7750 3.610  4.030  4.447  4.447  4.447  3.610   Y-N3B2-44
 2.7750 2.5638 1.9622 1.0619 0.0000                                     Y-N3B2-44
-3.3330-3.3330-3.3330-3.3330-3.3330-3.333 -2.9160-1.667 0.0     0.0     Z-N3B2-44
0.0    1.0619 1.9622 2.5638 2.7750                                      Z-N3B2-44
26.192545.845                                                           XFUS02     18
 0.0000 1.1790 2.7750 3.610  4.030  4.447  4.447  4.447  3.610  2.7750 Y-N3B2-44  20
2.5638 1.9622 1.0619 0.0                                                Y-N3B2-44  21
-3.3330-3.3330-3.3330-3.3330-3.3330-2.9160-1.667 0.0    0.0    0.0      Z-N3B2-44
1.0619 1.9622 2.5638 2.7750                                             Z-N3B2-44
 0.0000 1.1790 2.7750 3.610  4.030  4.447  4.447  4.447  3.610  2.7750 Y-N3B2-44
2.5638 1.9622 1.0619 0.0                                                Y-N3B2-44
-3.3330-3.3330-3.3330-3.3330-3.3330-2.9160-1.667 0.0    0.0    0.0      Z-N3B2-44
1.0619 1.9622 2.5638 2.7750                                             Z-N3B2-44
    FIVE SEGMENTS - SAME RADIAL SPACING - INLETS USE INPUT GEOMETRY                26
   0    0    7    0    2    0    2    0    2    0    4                   KCARD      27
   3   60   61   74   75   88   89   62   63   64   76   77   78   79    INLETA     28
  90   91   92   93   94  101  102  103  104  105  106  107              INLETA
0.58                                                                    INLETB     29
0.0    1.667  5.0    10.0   15.0   19.433 24.407                        XJ01       32
24.407 25.191                                                           XJ02
25.191 25.9422                                                          XJ02
25.942226.1925                                                          XJ02
26.192529.45  33.33  45.845                                             XJ04
-27.511   0.0        0.0                                                           34
13.001    24.0                                                                     35
   6   8                                                                           36
   1  -4.447     0.0       0.0       0.0                                           37
   2  -5.555     48.6      30.75     0.0
   3  -6.667     48.6      30.75     0.0
   4  -8.888     48.6      30.75     0.0
   5 -11.112     48.6      30.75     0.0
   6 -13.333     48.6      30.75     0.0
   7 -15.555     48.6      30.75     0.0
   8 -17.778     48.6      30.75     0.0
   9 -20.000     48.6      30.75     0.0
   0   0                                                                           38
  50   1   1                                                                       40
   1  -4.447     0.0       0.0       0.0                                           41
   2 -20.0       48.6      30.75     0.0
   .209     .190     .137     .114     .097     .084     .075     .066             42
```

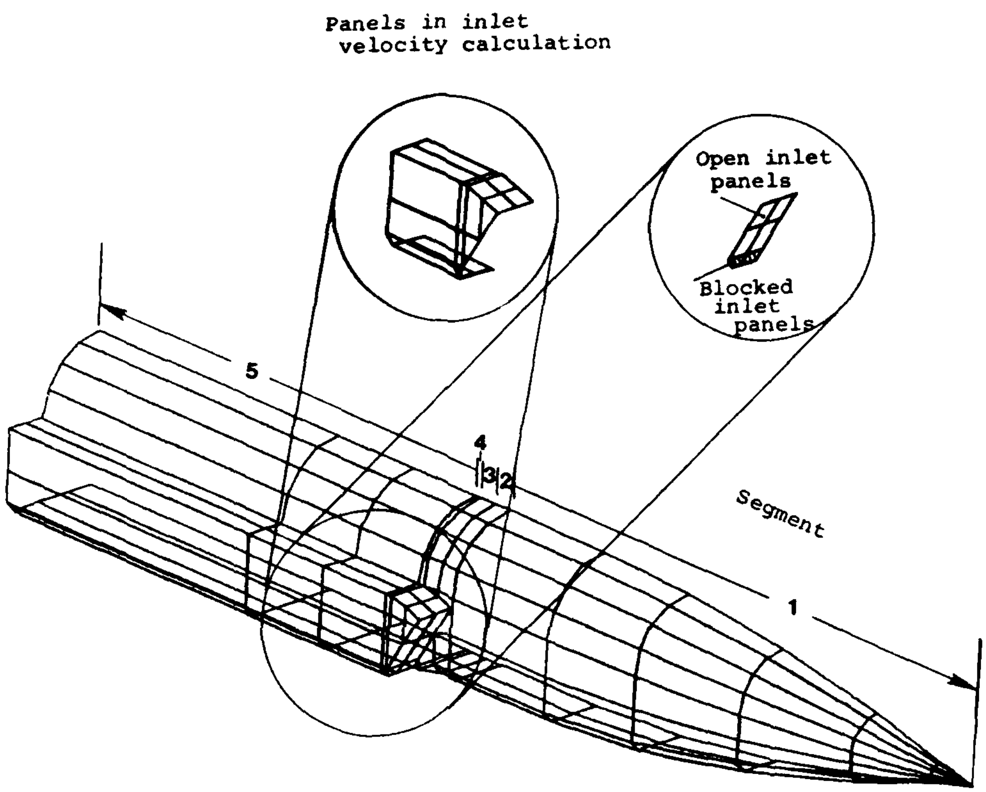
(b)

Figure 11.- Continued.

```
   .056       .052       .047       .041       .036       .031       .026       .021    42
   .010       .011       .007       .002      -.002      -.006      -.010      -.014  (Cont'd)
  -.018      -.022      -.026      -.029      -.033      -.037      -.041      -.045
  -.048      -.052      -.055      -.059      -.061      -.064      -.066      -.067
  -.067      -.067      -.067      -.067      -.067      -.067      -.067      -.067
  -.067      -.067
    0    4.442     0.75      -4.53                                                    43
    2    2                                                                            44
    1  3.333      0.0       0.0                                                       45
    2  3.7083     0.0       0.0
    3  4.0833     0.0       0.0
   40      1       1                                                                  46
    1  3.333      0.0       0.0                                                       47
    2  4.0833     0.0       0.0
 0.09629   0.09629   0.09629   0.09629   0.09629   0.09629   0.09629   0.09629        48
 0.09629   0.09629   0.09629   0.09629   0.09629   0.09629   0.09629   0.09629
 0.09629   0.09629   0.0       0.0       0.0       0.0      -0.09629  -0.09629
 -.09629   -.09629   -.09629   -.09629   -.09629   -.09629   -.09629   -.09629
 -.09629   -.09629   -.09629   -.09629   -.09629   -.09629   -.09629   -.09629
   10   52 10.0    1.25      0.0533    0.0      4.7063    0.0       0.0              54
    1                                                                                 55
   52    0  54.0                                                                      56
2 TO 1  ELLIPTIC OGIVE STORE, 9F - EXTERNAL SHAPE DEFINED BY FUSNY AND A/H            60
    1    1    1    1    0    1    0    3    8    0                          IOPTS     61
0.0     4.1667 0.575                                                       XRIP      62
    0    -5   -1    1   10   23                                            JCARD     63
0.0   0.2   0.4   0.6   0.8   1.0   1.2   1.4   1.6   1.8                  XSTR10    65
2.0   2.2   2.4   2.6   2.8   3.0   3.2   3.4   3.6   3.8                  XSTR20
4.0   4.167 10.                                                            XSTR23
0.0    0.1274 0.2463 0.3570 0.4601 0.5557 0.6444 0.7262 0.8015 0.8705      BYSTR10   68
0.9332 0.9900 1.0409 1.0861 1.1256 1.1595 1.1880 1.2110 1.2287 1.2411      BYSTR20
1.2482 1.2500 1.2500                                                       BYSTR23
0.5                                                                        AZ/BY10   70
                                                                           AZ/BY20
                                                                           AZ/BY23
      ELLIPTIC STORE - MERIDIONAL SPACING MATCHES INTERDIGITATED TAIL ANGLES         71
    1   -5   19                                                            KCARD     72
2.4564 1.7676 10.0    5.0    0.00                                          REFA/R    73
0.0    55.    90.    125.   180.                                           PHIOS     74
0.0    0.8    1.6    2.4    3.0    3.5    4.0    4.5    5.0    5.5        XJ10      75
5.833  6.5    7.0    7.5    8.0    8.333  8.75   9.2    10.0               XJ19
```

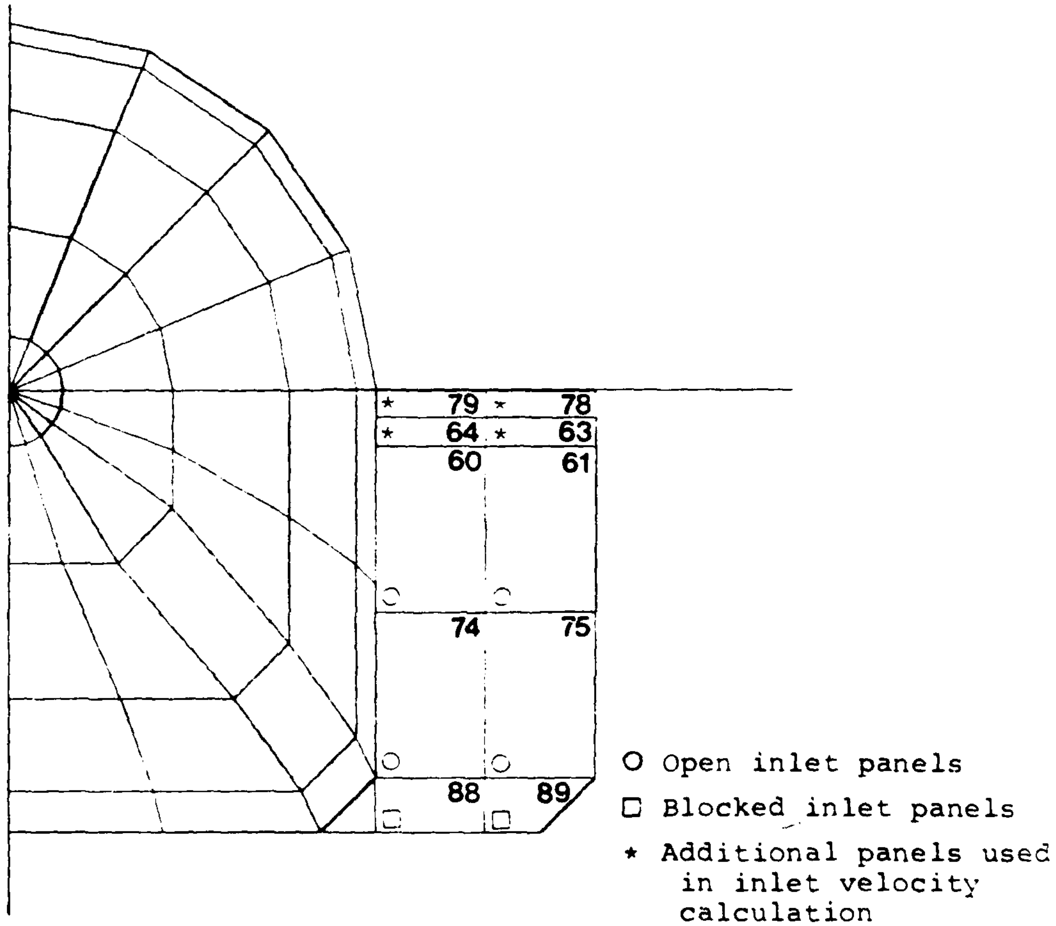
(c)

Figure 11.- Concluded.



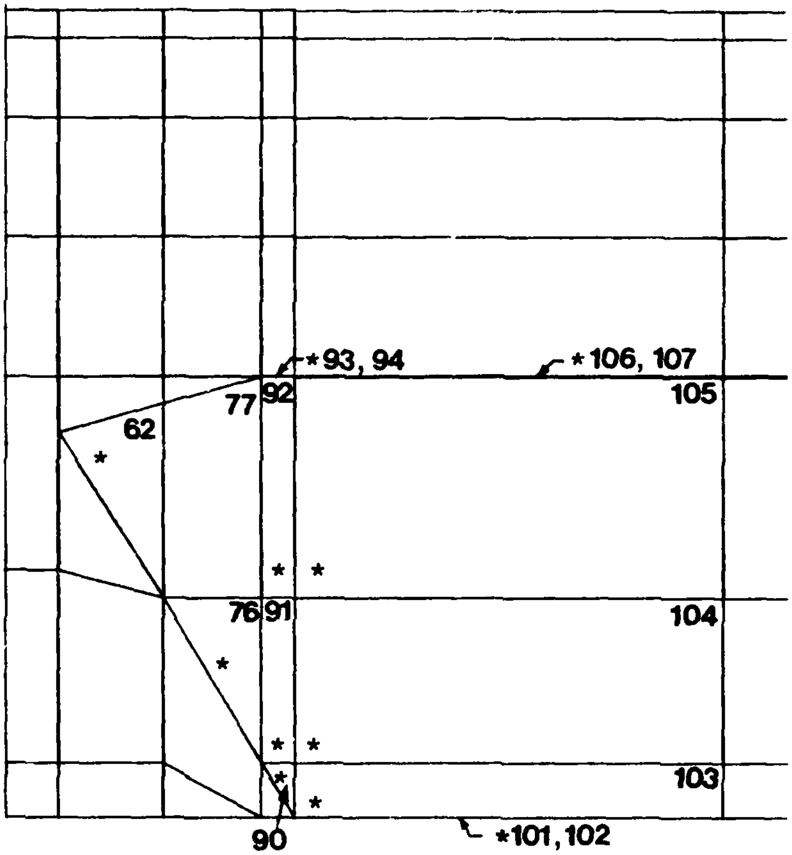
(a) Isometric projection

Figure 12.- Fuselage panel layout.



(b) Fuselage frontal view looking upstream showing inlet panels

Figure 12.- Continued.



* -Additional panels used in inlet velocity calculations

(c) Inlet layout side view showing panels used in inlet velocity calculations

Figure 12.- Concluded.

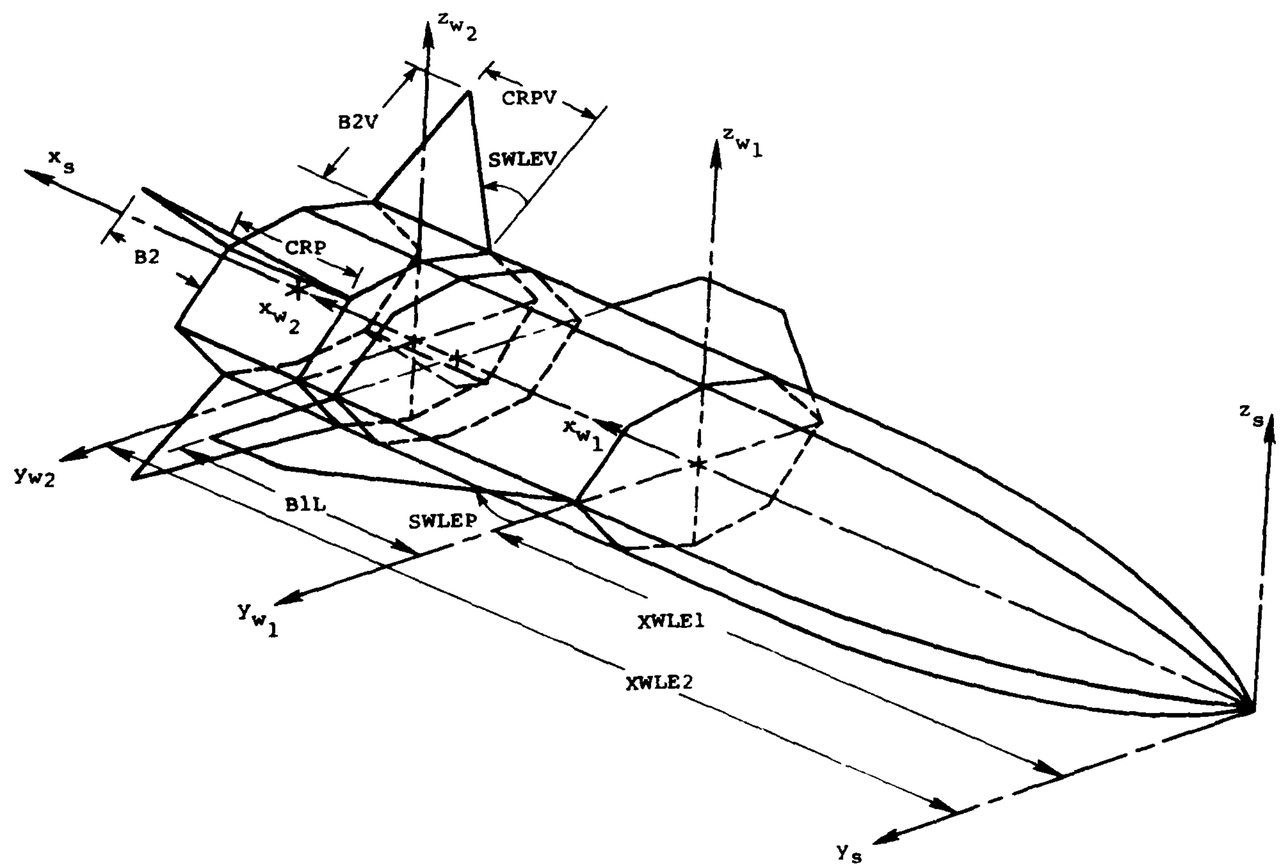


Figure 13.- Store body and empennage coordinates.

```
                    SUPERSONIC STORE/AIRCRAFT [illegible] BY [illegible]

WIND TUNNEL MODEL
   AIRCRAFT AND STORE ARE SCALED UP VERSIONS OF MODELS USED IN EXPERIMENTAL
        PROGRAM CONDUCTED IN CONJUNCTION WITH THIS WORK
   MODELS SCALED UP BY A FACTOR OF 20 TO APPROPRIATE FULL SCALE AIRCRAFT
   PARENT CONFIGURATION [illegible]
   MACH NUMBER = 1.5
   ANGLE OF ATTACK =  5.0 DEGREES
   2 [illegible] ELLIPTIC STORE MODEL - SP

AIRCRAFT FLIGHT CONDITIONS
   ANGLE OF ATTACK =  5.00 DEGREES
   MACH NUMBER = 1.50

FUSELAGE INPUT DATA
   [illegible] SOURCE PANELING METHOD

   FUSELAGE LENGTH =                  [illegible] FEET
   MAXIMUM RADIUS =                    [illegible] FEET
   NOSE TIP SHOCK ANGLE =             [illegible] DEGREES
   INTERFERENCE SHELL LENGTH =        [illegible] FEET
```

(a)

Figure 14.- Program I output for sample case.

```
NONCIRCULAR FUSELAGE MODEL - NSWC2WAN                                                      ** GEOM **

PANEL SYMMETRY OPTION                        (IXZSYM) =     0
                                                         INPUT GEOM SHOCK VEL BUCK
PRINT CONTROLS (NO=0,YES=1)                   (IPRT) =     1     1     1     0     1
U,V,W CALCULATION (YES=0,NO=1)                (IUVW) =     1
NUMBER OF SHOCK SHAPES                      (NSHOCK) =     3
MAXIMUM NUMBER OF POINTS IN SHAPE           (MAXSHK) =     8
OPEN INLET PANELS (0=NO, 1-25 PANELS)       (NINLET) =     4
CLOSED INLET PANELS                         (NINCLS) =     2
INLET PANELS IN FIELD VELOCITY CALC         (NINVEL) =    19

VALUE FOR INTERFERENCE SHELL GEOMETRY        (XNTP) =  20.000
NOSE SHOULDER LOCATION FOR SHOCK           (XSHLDR) = 0.
RATIO FOR SHOCK ROTATION WITH ALPHA        (FALPHA) =   .31500

          EXTERNAL GEOMETRY OPTIONS AND SHAPE
READ REF. AREA CARD (NO=0,YES=1)                (J0) =     0
EXTERNAL GEOMETRY TYPE                          (J2) =     1
READ Z-CENTERLINE (NO=-1, YES=0)                (J6) =    -1
NUMBER OF BODY SEGMENTS                       (NFUS) =     5
                                             SEGMENT     (1)   (2)   (3)   (4)   (5)
NUMBER OF GEOMETRY CORNER MERIDIANS          (NRADX) =    10    16    16    15    14
NUMBER OF CROSS SECTION AXIALLY              (NFORX) =    19     2     2     2     2


      VEHICLE GEOMETRY DEFINITION                                                          ** CONFIG **
REFERENCE AREA (J0.GT.0)      REFA=  1.00000

NFU      XFUS - BODY X-STATIONS
 1     0.0000    1.6670    4.0000    5.0000    6.0000    6.6670    7.5000    8.3330   10.0000   10.8330
      11.6670   13.3330   14.0000   15.0000   16.0000   16.6670   18.0000   19.8330   26.6070

JX=  1      ARBITRARY BODY COORDINATES (SFUS)
Y=     0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000

Z=     0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000

JX=  2      ARBITRARY BODY COORDINATES (SFUS)
Y=     0.0000     .1289     .2451     .3374     .3966     .4170     .3953     .2940     .1596    0.0000

Z=     -.4170    -.3966    -.3374    -.2451    -.1289    0.0000     .1596     .2940     .3953     .4170

JX=  3      ARBITRARY BODY COORDINATES (SFUS)
Y=     0.0000     .6210     .9150    1.0380    1.0380    1.0380     .9590     .7340     .3972    0.0000

Z=    -1.0650   -1.0650    -.9424    -.6480    -.3240    0.0000     .3972     .7340     .9590    1.0380

JX=  4      ARBITRARY BODY COORDINATES (SFUS)
Y=     0.0000     .4205     .8330    1.2510    1.2500    1.2500    1.1540     .8839     .4788    0.0000
```

(b)

Figure 14.- Continued.

```
Z=   -1,2970  -1,2970  -1,2970   -,8880   -,4400   0,0000    ,4784    ,8830   1,1508   1,2500

JX=  5    ARBITRARY BODY COORDINATES (BFUS)
Y=    0,0000    ,5230   1,0460   1,4630   1,4630   1,4630   1,3516   1,0345    ,5599   0,0000

Z=   -1,5350  -1,5350  -1,5350  -1,1180   -,5590   0,0000    ,5599   1,0345   1,3516   1,4630

JX=  6    ARBITRARY BODY COORDINATES (BFUS)
Y=    0,0000    ,5875   1,1750   1,5920   1,5920   1,5920   1,4708   1,1257    ,6092   0,0000

Z=   -1,6820  -1,6820  -1,6820  -1,2650   -,6325   0,0000    ,6092   1,1257   1,4708   1,5920

JX=  7    ARBITRARY BODY COORDINATES (BFUS)
Y=    0,0000    ,6625   1,3250   1,7420   1,7420   1,7420   1,6094   1,2318    ,6666   0,0000

Z=   -1,8570  -1,8570  -1,8570  -1,4400   -,7200   0,0000    ,6666   1,2318   1,6094   1,7420

JX=  8    ARBITRARY BODY COORDINATES (BFUS)
Y=    0,0000    ,7325   1,4650   1,8820   1,8820   1,8820   1,7387   1,3308    ,7202   0,0000

Z=   -2,0230  -2,0230  -2,0230  -1,6060   -,8032   0,0000    ,7202   1,3308   1,7387   1,8820

JX=  9    ARBITRARY BODY COORDINATES (BFUS)
Y=    0,0000    ,8500   1,7080   2,1250   2,1250   2,1250   1,9632   1,5026    ,8132   0,0000

Z=   -2,3250  -2,3250  -2,3250  -1,9080   -,9540   0,0000    ,8132   1,5026   1,9632   2,1250

JX= 10    ARBITRARY BODY COORDINATES (BFUS)
Y=    0,0000    ,9150   1,8300   2,2470   2,2470   2,2470   2,0760   1,5889    ,8599   0,0000

Z=   -2,4800  -2,4800  -2,4800  -2,0630  -1,0315   0,0000    ,8599   1,5889   2,0760   2,2470

JX= 11    ARBITRARY BODY COORDINATES (BFUS)
Y=    0,0000    ,9615   1,9230   2,3400   2,3400   2,3400   2,1619   1,6546    ,8955   0,0000

Z=   -2,6350  -2,6350  -2,6350  -2,2180  -1,1090   0,0000    ,8955   1,6546   2,1619   2,3400

JX= 12    ARBITRARY BODY COORDINATES (BFUS)
Y=    0,0000   1,0450   2,0900   2,5070   2,5070   2,5070   2,3162   1,7727    ,9594   0,0000

Z=   -2,8370  -2,8370  -2,8370  -2,4200  -1,2100   0,0000    ,9594   1,7727   2,3162   2,5070

JX= 13    ARBITRARY BODY COORDINATES (BFUS)
Y=    0,0000   1,0700   2,1400   2,5570   2,5570   2,5570   2,3624   1,8081    ,9785   0,0000

Z=   -2,9120  -2,9120  -2,9120  -2,4950  -1,2475   0,0000    ,9785   1,8081   2,3624   2,5570

JX= 14    ARBITRARY BODY COORDINATES (BFUS)
Y=   [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]
```

(c)

Figure 14.- Continued.

```
Z=    -3.0280   -3.0280   -3.0280   -2.6110   -1.3060    0.0000    1.0074    1.8618    2.4326    2.6330

JX= 15     ARBITRARY BODY COORDINATES (BFUS)
Y=     0.0000    1.1365    2.2730    2.6900    2.6900    2.6900    2.4852    1.9021    1.0296    0.0000

Z=    -3.1230   -3.1230   -3.1230   -2.7060   -1.5530    0.0000    1.0296    1.9021    2.4852    2.6900

JX= 16     ARBITRARY BODY COORDINATES (BFUS)
Y=     0.0000    1.1515    2.3030    2.7200    2.7200    2.7200    2.5130    1.9233    1.0409    0.0000

Z=    -3.1800   -3.1800   -3.1800   -2.7630   -1.5815    0.0000    1.0409    1.9233    2.5130    2.7200

JX= 17     ARBITRARY BODY COORDINATES (BFUS)
Y=     0.0000    1.1675    2.3350    2.7520    2.7520    2.7520    2.5425    1.9460    1.0531    0.0000

Z=    -3.2580   -3.2580   -3.2580   -2.8410   -1.6205    0.0000    1.0531    1.9460    2.5425    2.7520

JX= 18     ARBITRARY BODY COORDINATES (BFUS)
Y=     0.0000    1.1790    2.3580    2.7750    2.7750    2.7750    2.5638    1.9622    1.0619    0.0000

Z=    -3.3330   -3.3330   -3.3330   -2.9160   -1.6580    0.0000    1.0619    1.9622    2.5638    2.7750

JX= 19     ARBITRARY BODY COORDINATES (BFUS)
Y=     0.0000    1.1790    2.3580    2.7750    2.7750    2.7750    2.5638    1.9622    1.0619    0.0000

Z=    -3.3330   -3.3330   -3.3330   -2.9160   -1.6580    0.0000    1.0619    1.9622    2.5638    2.7750


NFU     XFUS = BODY X-STATIONS
  2   24.6070   25.1910

JX=  1     ARBITRARY BODY COORDINATES (BFUS)
Y=     0.0000    1.1790    2.3580    2.7750    2.7750    2.7750    3.6100    4.4470    4.4470    3.6100
       2.7750    2.7750    2.5638    1.9622    1.0619    0.0000
Z=    -3.3330   -3.3330   -3.3330   -2.9160   -1.6980    -.4167    -.4167    -.4167    -.4167    -.4167
       -.4167    0.0000    1.0619    1.9622    2.5638    2.7750

JX=  2     ARBITRARY BODY COORDINATES (BFUS)
Y=     0.0000    1.1790    2.3580    2.7750    2.7750    2.7750    3.6100    4.4470    4.4470    3.6100
       2.7750    2.7750    2.5638    1.9622    1.0619    0.0000
Z=    -3.3330   -3.3330   -3.3330   -2.9160   -1.6670   -1.6670   -1.6670   -1.6670    -.2000    -.2000
       -.2000    0.0000    1.0619    1.9622    2.5638    2.7750

NFU     XFUS = BODY X-STATIONS
  3   25.1910   25.9422

JX=  1     ARBITRARY BODY COORDINATES (BFUS)
Y=     0.0000    1.1790    2.3580    2.7750    2.7750    3.6100    4.4470    4.4470    4.4470    3.6100
       2.7750    2.7750    2.5638    1.9622    1.0619    0.0000
Z=    -3.3330   -3.3330   -3.3330   -2.9160   -1.6670   -1.6670   -1.6670   -1.6670    -.2000    -.2000
       -.2000    0.0000    1.0619    1.9622    2.5638    2.7750
```

(d)

Figure 14.- Continued.

```
J=  2     ARBITRARY BODY COORDINATES (BFUS)
Y=     0.0000    1.1790    2.7750    2.7750    2.7750    3.6100    4.4470    4.4470    4.4470    3.6100
       2.7750    2.7750    2.5638    1.9622    1.0619    0.0000
Z=    -3.3330   -3.3330   -3.3330   -3.3330   -2.9160   -2.9160   -2.9160   -1.6670    0.0000    0.0000
       0.0000    0.0000    1.0619    1.9622    2.5638    2.7750

NFU      XFUS = BODY X-STATIONS
  4    25.9422   26.1925

J=  1     ARBITRARY BODY COORDINATES (BFUS)
Y=     0.0000    1.1790    2.7750    2.7750    3.6100    4.4470    4.4470    4.4470    4.4470    3.6100
       2.7750    2.5638    1.9622    1.0619    0.0000
Z=    -3.3330   -3.3330   -3.3330   -2.9160   -2.9160   -2.9160   -2.9160   -1.6670    0.0000    0.0000
       0.0000    1.0619    1.9622    2.5638    2.7750

J=  2     ARBITRARY BODY COORDINATES (BFUS)
Y=     0.0000    1.1790    2.7750    2.7750    3.6100    4.0300    4.4470    4.4470    4.4470    3.6100
       2.7750    2.5638    1.9622    1.0619    0.0000
Z=    -3.3330   -3.3330   -3.3330   -3.3330   -3.3330   -3.3330   -2.9160   -1.6670    0.0000    0.0000
       0.0000    1.0619    1.9622    2.5638    2.7750

NFU      XFUS = BODY X-STATIONS
  5    26.1925   45.8850

J=  1     ARBITRARY BODY COORDINATES (BFUS)
Y=     0.0000    1.1790    2.7750    3.6100    4.0300    4.4470    4.4470    4.4470    3.6100    2.7750
       2.5638    1.9622    1.0619    0.0000
Z=    -3.3330   -3.3330   -3.3330   -3.3330   -3.3330   -2.9160   -1.6670    0.0000    0.0000    0.0000
       1.0619    1.9622    2.5638    2.7750

J=  2     ARBITRARY BODY COORDINATES (BFUS)
Y=     0.0000    1.1790    2.7750    3.6100    4.0300    4.4470    4.4470    4.4470    3.6100    2.7750
       2.5638    1.9622    1.0619    0.0000
Z=    -3.3330   -3.3330   -3.3330   -3.3330   -3.3330   -2.9160   -1.6670    0.0000    0.0000    0.0000
       1.0619    1.9622    2.5638    2.7750

          CROSS SECTIONAL AREAS
MAXIMUM AREA =  41.257        SHOULDER AREA =  30.112        X-SHOULDER =  19.435        BODY LENGTH =  45.885
```

(e)

Figure 14.- Continued.

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     FIVE SEGMENTS - SAME RADIAL SPACING - INLETS USE INPUT GEOMETRY                              ** GEOM **

             REVISED PANELING GEOMETRY OPTIONS AND SHAPE
  READ REFERENCE LENGTH CARD (NO=0, YES=1)      (KO) =     0
  NUMBER OF BODY PANELING SEGMENTS            (NFUS) =     5
                                              SEGMENT     (1)  (2)  (3)  (4)  (5)
  NUMBER OF PANEL CORNERS RADIALLY           (NRADX) =     8    8    8    0    0
  NUMBER OF PANEL CROSS SECTIONS AXIALLY     (NFORX) =     7    2    2    2    4

  TOTAL NUMBER OF INLET PANELS              (NTINLT) =    25
  NUMBER OF INLET SHOCK SHAPE TRAVERSES       (NTIS) =     1
  OPEN INLET PANEL NUMBERS                   (JINLT) =    60   61   74   75
  CLOSED INLET PANEL NUMBERS                 (JINLT) =    88   89
  PANEL NUMBERS IN FIELD VELOCITY CALC       (JINLT) =    62   63   64   76   77
                                                          78   79   80   91   92
                                                          93   94  101  102  103
                                                         104  105  106  107

  INLET SHOCK PARAMETER - BETA              (BTINLT) =     .50000

IFUS    1
 XJ= 0.          1.0070     5.0000     10.000     15.000     19.433     24.407

IFUS    2
 XJ=  24.407     25.101

IFUS    3
 XJ=  25.101     25.942

IFUS    4
 XJ=  25.942     26.193

IFUS    5
 XJ=  26.193     29.450     33.330     45.845
```

(f)

Figure 14.- Continued.

BODY PANEL CORNER POINT COORDINATES ** BODPAN **

1 AND 3 INDICATE BODY PANEL LEADING-EDGE POINTS, 2 AND 4 INDICATE TRAILING-EDGE POINTS

PANEL	X 1	Y 1	Z 1	X 2	Y 2	Z 2	X 3	Y 3	Z 3	X 4	Y 4	Z 4
1	0,00000	0,00000	0,00000	1,66700	0,00000	-,41700	0,00000	0,00000	0,00000	1,66700	,12890	-,39660
2	0,00000	0,00000	0,00000	1,66700	,12890	-,39660	0,00000	0,00000	0,00000	1,66700	,24510	-,33740
3	0,00000	0,00000	0,00000	1,66700	,24510	-,33740	0,00000	0,00000	0,00000	1,66700	,33740	-,24510
4	0,00000	0,00000	0,00000	1,66700	,33740	-,24510	0,00000	0,00000	0,00000	1,66700	,39660	-,12890
5	0,00000	0,00000	0,00000	1,66700	,39660	-,12890	0,00000	0,00000	0,00000	1,66700	,41700	0,00000
6	0,00000	0,00000	0,00000	1,66700	,41700	0,00000	0,00000	0,00000	0,00000	1,66700	,38530	,15960
7	0,00000	0,00000	0,00000	1,66700	,38530	,15960	0,00000	0,00000	0,00000	1,66700	,29490	,29490
8	0,00000	0,00000	0,00000	1,66700	,29490	,29490	0,00000	0,00000	0,00000	1,66700	,15960	,38530
9	0,00000	0,00000	0,00000	1,66700	,15960	,38530	0,00000	0,00000	0,00000	1,66700	0,00000	,41700
10	1,66700	0,00000	-,41700	5,00000	0,00000	-1,29700	1,66700	,12890	-,39660	5,00000	,41650	-1,29700
11	1,66700	,12890	-,39660	5,00000	,41650	-1,29700	1,66700	,24510	-,33740	5,00000	,83300	-1,29700
12	1,66700	,24510	-,33740	5,00000	,83300	-1,29700	1,66700	,33740	-,24510	5,00000	1,25000	-,88000
13	1,66700	,33740	-,24510	5,00000	1,25000	-,88000	1,66700	,39660	-,12890	5,00000	1,25000	-,44000
14	1,66700	,39660	-,12890	5,00000	1,25000	-,44000	1,66700	,41700	0,00000	5,00000	1,25000	0,00000
15	1,66700	,41700	0,00000	5,00000	1,25000	0,00000	1,66700	,38530	,15960	5,00000	1,15480	,47840
16	1,66700	,38530	,15960	5,00000	1,15480	,47840	1,66700	,29490	,29490	5,00000	,88390	,88390
17	1,66700	,29490	,29490	5,00000	,88390	,88390	1,66700	,15960	,38530	5,00000	,47840	1,15480
18	1,66700	,15960	,38530	5,00000	,47840	1,15480	1,66700	0,00000	,41700	5,00000	0,00000	1,25000
19	5,00000	0,00000	-1,29700	10,00000	0,00000	-2,32500	5,00000	,41650	-1,29700	10,00000	,85400	-2,32500
20	5,00000	,41650	-1,29700	10,00000	,85400	-2,32500	5,00000	,83300	-1,29700	10,00000	1,70800	-2,32500
21	5,00000	,83300	-1,29700	10,00000	1,70800	-2,32500	5,00000	1,25000	-,88000	10,00000	2,12500	-1,90800
22	5,00000	1,25000	-,88000	10,00000	2,12500	-1,90800	5,00000	1,25000	-,44000	10,00000	2,12500	-,95400
23	5,00000	1,25000	-,44000	10,00000	2,12500	-,95400	5,00000	1,25000	0,00000	10,00000	2,12500	0,00000
24	5,00000	1,25000	0,00000	10,00000	2,12500	0,00000	5,00000	1,15480	,47840	10,00000	1,96320	,81320
25	5,00000	1,15480	,47840	10,00000	1,96320	,81320	5,00000	,88390	,88390	10,00000	1,50260	1,50260
26	5,00000	,88390	,88390	10,00000	1,50260	1,50260	5,00000	,47840	1,15480	10,00000	,81320	1,96320
27	5,00000	,47840	1,15480	10,00000	,81320	1,96320	5,00000	0,00000	1,25000	10,00000	0,00000	2,12500
28	10,00000	0,00000	-2,32500	15,00000	0,00000	-3,02800	10,00000	,85400	-2,32500	15,00000	1,10800	-3,02800
29	10,00000	,85400	-2,32500	15,00000	1,10800	-3,02800	10,00000	1,70800	-2,32500	15,00000	2,21600	-3,02800
30	10,00000	1,70800	-2,32500	15,00000	2,21600	-3,02800	10,00000	2,12500	-1,90800	15,00000	2,63300	-2,61100
31	10,00000	2,12500	-1,90800	15,00000	2,63300	-2,61100	10,00000	2,12500	-,95400	15,00000	2,63300	-1,30600
32	10,00000	2,12500	-,95400	15,00000	2,63300	-1,30600	10,00000	2,12500	0,00000	15,00000	2,63300	0,00000
33	10,00000	2,12500	0,00000	15,00000	2,63300	0,00000	10,00000	1,96320	,81320	15,00000	2,43260	1,00760
34	10,00000	1,96320	,81320	15,00000	2,43260	1,00760	10,00000	1,50260	1,50260	15,00000	1,86180	1,86180
35	10,00000	1,50260	1,50260	15,00000	1,86180	1,86180	10,00000	,81320	1,96320	15,00000	1,00760	2,43260
36	10,00000	,81320	1,96320	15,00000	1,00760	2,43260	10,00000	0,00000	2,12500	15,00000	0,00000	2,63300
37	15,00000	0,00000	-3,02800	19,43300	0,00000	-3,33300	15,00000	1,10800	-3,02800	19,43300	1,17900	-3,33300
38	15,00000	1,10800	-3,02800	19,43300	1,17900	-3,33300	15,00000	2,21600	-3,02800	19,43300	2,35800	-3,33300
39	15,00000	2,21600	-3,02800	19,43300	2,35800	-3,33300	15,00000	2,63300	-2,61100	19,43300	2,77500	-2,91600
40	15,00000	2,63300	-2,61100	19,43300	2,77500	-2,91600	15,00000	2,63300	-1,30600	19,43300	2,77500	-1,45800
41	15,00000	2,63300	-1,30600	19,43300	2,77500	-1,45800	15,00000	2,63300	0,00000	19,43300	2,77500	0,00000
42	15,00000	2,63300	0,00000	19,43300	2,77500	0,00000	15,00000	2,43260	1,00760	19,43300	2,56380	1,06190
43	15,00000	2,43260	1,00760	19,43300	2,56380	1,06190	15,00000	1,86180	1,86180	19,43300	1,96220	1,96220
44	15,00000	1,86180	1,86180	19,43300	1,96220	1,96220	15,00000	1,00760	2,43260	19,43300	1,06190	2,56380
45	15,00000	1,00760	2,43260	19,43300	1,06190	2,56380	15,00000	0,00000	2,63300	19,43300	0,00000	2,77500
46	19,43300	0,00000	-3,33300	24,40700	0,00000	-3,33300	19,43300	1,17900	-3,33300	24,40700	1,17900	-3,33300
47	19,43300	1,17900	-3,33300	24,40700	1,17900	-3,33300	19,43300	2,35800	-3,33300	24,40700	2,35800	-3,33300
48	19,43300	2,35800	-3,33300	24,40700	2,35800	-3,33300	19,43300	2,77500	-2,91600	24,40700	2,77500	-2,91600
49	19,43300	2,77500	-2,91600	24,40700	2,77500	-2,91600	19,43300	2,77500	-1,45800	24,40700	2,77500	-1,45800
50	19,43300	2,77500	-1,45800	24,40700	2,77500	-1,45800	19,43300	2,77500	0,00000	24,40700	2,77500	0,00000
51	19,43300	2,77500	0,00000	24,40700	2,77500	0,00000	19,43300	2,56380	1,06190	24,40700	2,56380	1,06190
52	19,43300	2,56380	1,06190	24,40700	2,56380	1,06190	19,43300	1,96220	1,96220	24,40700	1,96220	1,96220
53	19,43300	1,96220	1,96220	24,40700	1,96220	1,96220	19,43300	1,06190	2,56380	24,40700	1,06190	2,56380

(g)

Figure 14.- Continued.

54	19,43300	1,06190	2,56380	24,40700	1,06190	2,56380	19,43300	0,00000	2,77500	24,40700	0,00000	2,77500
55	24,40700	0,00000	-3,33300	25,19100	0,00000	-3,33300	24,40700	1,17900	-3,33300	25,19100	1,17900	-3,33300
56	24,40700	1,17900	-3,33300	25,19100	1,17900	-3,33300	24,40700	2,35800	-3,33300	25,19100	2,35800	-3,33300
57	24,40700	2,35800	-3,33300	25,19100	2,35800	-3,33300	24,40700	2,77500	-2,91600	25,19100	2,77500	-2,91600
58	24,40700	2,77500	-2,91600	25,19100	2,77500	-2,91600	24,40700	2,77500	-1,45800	25,19100	2,77500	-1,66700
59	24,40700	2,77500	-1,45800	25,19100	2,77500	-1,66700	24,40700	2,77500	-,41670	25,19100	2,77500	-1,66700
60	24,40700	2,77500	-,41670	25,19100	2,77500	-1,66700	24,40700	3,61000	-,41670	25,19100	3,61000	-1,66700
61	24,40700	3,61000	-,41670	25,19100	3,61000	-1,66700	24,40700	4,44700	-,41670	25,19100	4,44700	-1,66700
62	24,40700	4,44700	-,41670	25,19100	4,44700	-1,66700	24,40700	4,44700	-,41670	25,19100	4,44700	-,20000
63	24,40700	4,44700	-,41670	25,19100	4,44700	-,20000	24,40700	3,61000	-,41670	25,19100	3,61000	-,20000
64	24,40700	3,61000	-,41670	25,19100	3,61000	-,20000	24,40700	2,77500	-,41670	25,19100	2,77500	-,20000
65	24,40700	2,77500	-,41670	25,19100	2,77500	-,20000	24,40700	2,77500	0,00000	25,19100	2,77500	0,00000
66	24,40700	2,77500	0,00000	25,19100	2,77500	0,00000	24,40700	2,56380	1,06190	25,19100	2,56380	1,06190
67	24,40700	2,56380	1,06190	25,19100	2,56380	1,06190	24,40700	1,96220	1,96220	25,19100	1,96220	1,96220
68	24,40700	1,96220	1,96220	25,19100	1,96220	1,96220	24,40700	1,06190	2,56380	25,19100	1,06190	2,56380
69	24,40700	1,06190	2,56380	25,19100	1,06190	2,56380	24,40700	0,00000	2,77500	25,19100	0,00000	2,77500
70	25,19100	0,00000	-3,33300	25,94220	0,00000	-3,33300	25,19100	1,17900	-3,33300	25,94220	1,17900	-3,33300
71	25,19100	1,17900	-3,33300	25,94220	1,17900	-3,33300	25,19100	2,35800	-3,33300	25,94220	2,77500	-3,33300
72	25,19100	2,35800	-3,33300	25,94220	2,77500	-3,33300	25,19100	2,77500	-2,91600	25,94220	2,77500	-3,33300
73	25,19100	2,77500	-2,91600	25,94220	2,77500	-3,33300	25,19100	2,77500	-1,66700	25,94220	2,77500	-2,91600
74	25,19100	2,77500	-1,66700	25,94220	2,77500	-2,91600	25,19100	3,61000	-1,66700	25,94220	3,61000	-2,91600
75	25,19100	3,61000	-1,66700	25,94220	3,61000	-2,91600	25,19100	4,44700	-1,66700	25,94220	4,44700	-2,91600
76	25,19100	4,44700	-1,66700	25,94220	4,44700	-2,91600	25,19100	4,44700	-1,66700	25,94220	4,44700	-1,66700
77	25,19100	4,44700	-1,66700	25,94220	4,44700	-1,66700	25,19100	4,44700	-,20000	25,94220	4,44700	0,00000
78	25,19100	4,44700	-,20000	25,94220	4,44700	0,00000	25,19100	3,61000	-,20000	25,94220	3,61000	0,00000
79	25,19100	3,61000	-,20000	25,94220	3,61000	0,00000	25,19100	2,77500	-,20000	25,94220	2,77500	0,00000
80	25,19100	2,77500	-,20000	25,94220	2,77500	0,00000	25,19100	2,77500	0,00000	25,94220	2,77500	0,00000
81	25,19100	2,77500	0,00000	25,94220	2,77500	0,00000	25,19100	2,56380	1,06190	25,94220	2,56380	1,06190
82	25,19100	2,56380	1,06190	25,94220	2,56380	1,06190	25,19100	1,96220	1,96220	25,94220	1,96220	1,96220
83	25,19100	1,96220	1,96220	25,94220	1,96220	1,96220	25,19100	1,06190	2,56380	25,94220	1,06190	2,56380
84	25,19100	1,06190	2,56380	25,94220	1,06190	2,56380	25,19100	0,00000	2,77500	25,94220	0,00000	2,77500
85	25,94220	0,00000	-3,33300	26,19250	0,00000	-3,33300	25,94220	1,17900	-3,33300	26,19250	1,17900	-3,33300
86	25,94220	1,17900	-3,33300	26,19250	1,17900	-3,33300	25,94220	2,77500	-3,33300	26,19250	2,77500	-3,33300
87	25,94220	2,77500	-3,33300	26,19250	2,77500	-3,33300	25,94220	2,77500	-2,91600	26,19250	2,77500	-3,33300
88	25,94220	2,77500	-2,91600	26,19250	2,77500	-3,33300	25,94220	3,61000	-2,91600	26,19250	3,61000	-3,33300
89	25,94220	3,61000	-2,91600	26,19250	3,61000	-3,33300	25,94220	4,44700	-2,91600	26,19250	4,03000	-3,33300
90	25,94220	4,44700	-2,91600	26,19250	4,03000	-3,33300	25,94220	4,44700	-2,91600	26,19250	4,44700	-2,91600
91	25,94220	4,44700	-2,91600	26,19250	4,44700	-2,91600	25,94220	4,44700	-1,66700	26,19250	4,44700	-1,66700
92	25,94220	4,44700	-1,66700	26,19250	4,44700	-1,66700	25,94220	4,44700	0,00000	26,19250	4,44700	0,00000
93	25,94220	4,44700	0,00000	26,19250	4,44700	0,00000	25,94220	3,61000	0,00000	26,19250	3,61000	0,00000
94	25,94220	3,61000	0,00000	26,19250	3,61000	0,00000	25,94220	2,77500	0,00000	26,19250	2,77500	0,00000
95	25,94220	2,77500	0,00000	26,19250	2,77500	0,00000	25,94220	2,56380	1,06190	26,19250	2,56380	1,06190
96	25,94220	2,56380	1,06190	26,19250	2,5638	1,06190	25,94220	1,96220	1,96220	26,19250	1,96220	1,96220
97	25,94220	1,96220	1,96220	26,19250	1,96220	1,96220	25,94220	1,06190	2,56380	26,19250	1,06190	2,56380
98	25,94220	1,06190	2,56380	26,19250	1,06190	2,56380	25,94220	0,00000	2,77500	26,19250	0,00000	2,77500
99	26,19250	0,00000	-3,33300	29,45000	0,00000	-3,33300	26,19250	1,17900	-3,33300	29,45000	1,17900	-3,33300
100	26,19250	1,17900	-3,33300	29,45000	1,17900	-3,33300	26,19250	2,77500	-3,33300	29,45000	2,77500	-3,33300
101	26,19250	2,77500	-3,33300	29,45000	2,77500	-3,33300	26,19250	3,61000	-3,33300	29,45000	3,61000	-3,33300
102	26,19250	3,61000	-3,33300	29,45000	3,61000	-3,33300	26,19250	4,03000	-3,33300	29,45000	4,03000	-3,33300
103	26,19250	4,03000	-3,33300	29,45000	4,03000	-3,33300	26,19250	4,44700	-2,91600	29,45000	4,44700	-2,91600
104	26,19250	4,44700	-2,91600	29,45000	4,44700	-2,91600	26,19250	4,44700	-1,66700	29,45000	4,44700	-1,66700
105	26,19250	4,44700	-1,66700	29,45000	4,44700	-1,66700	26,19250	4,44700	0,00000	29,45000	4,44700	0,00000
106	26,19250	4,44700	0,00000	29,45000	4,44700	0,00000	26,19250	3,61000	0,00000	29,45000	3,61000	0,00000
107	26,19250	3,61000	0,00000	29,45000	3,61000	0,00000	26,19250	2,77500	0,00000	29,45000	2,77500	0,00000
108	26,19250	2,77500	0,00000	29,45000	2,77500	0,00000	26,19250	2,56380	1,06190	29,45000	2,56380	1,06190
109	26,19250	2,56380	1,06190	29,45000	2,56380	1,06190	26,19250	1,96220	1,96220	29,45000	1,96220	1,96220
110	26,19250	1,96220	1,96220	29,45000	1,96220	1,96220	26,19250	1,06190	2,56380	29,45000	1,06190	2,56380
111	26,19250	1,06190	2,56380	29,45000	1,0619	2,56380	26,19250	0,00000	2,77500	29,45000	0,00000	2,77500
112	29,45000	0,00000	-3,33300	33,33000	0,00000	-3,333	29,45000	1,17900	-3,33300	33,33000	1,17900	-3,33300
113	29,45000	1,17900	-3,33300	33,33000	1,17900	-3,33300	29,45000	2,77500	-3,33300	33,33000	2,775	-3,333

(h)

Figure 14.- Continued.

114	29,45000	2,77500	-3,33300	33,33000	2,77500	-3,33300	29,45000	3,61000	-3,33300	33,33000	3,61000	-3,33300
115	29,45000	3,61000	-3,33300	33,33000	3,61000	-3,33300	29,45000	4,03000	-3,33300	33,33000	4,03000	-3,33300
116	29,45000	4,03000	-3,33300	33,33000	4,03000	-1,33300	29,45000	4,44700	-2,91600	33,33000	4,44700	-2,91600
117	29,45000	4,44700	-2,91600	33,33000	4,44700	-2,91600	29,45000	4,44700	-1,66700	33,33000	4,44700	-1,66700
118	29,45000	4,44700	-1,66700	33,33000	4,44700	-1,66700	29,45000	4,44700	0,00000	33,33000	4,44700	0,00000
119	29,45000	4,44700	0,00000	33,33000	4,44700	0,00000	29,45000	3,61000	0,00000	33,33000	3,61000	0,00000
120	29,45000	3,61000	0,00000	33,33000	3,61000	0,00000	29,45000	2,77500	0,00000	33,33000	2,77500	0,00000
121	29,45000	2,77500	0,00000	33,33000	2,77500	0,00000	29,45000	2,56380	1,06190	33,33000	2,56380	1,06190
122	29,45000	2,56380	1,06190	33,33000	2,56380	1,06190	29,45000	1,96220	1,96220	33,33000	1,96220	1,96220
123	29,45000	1,96220	1,96220	33,33000	1,96220	1,96220	29,45000	1,06190	2,56380	33,33000	1,06190	2,56380
124	29,45000	1,06190	2,56380	33,33000	1,06190	2,56380	29,45000	0,00000	2,77500	33,33000	0,00000	2,77500
125	33,33000	0,00000	-3,33300	45,84500	0,00000	-3,33300	33,33000	1,17900	-3,33300	45,84500	1,17900	-3,33300
126	33,33000	1,17900	-3,33300	45,84500	1,17900	-3,33300	33,33000	2,77500	-3,33300	45,84500	2,77500	-3,33300
127	33,33000	2,77500	-3,33300	45,84500	2,77500	-3,33300	33,33000	3,61000	-3,33300	45,84500	3,61000	-3,33300
128	33,33000	3,61000	-3,33300	45,84500	3,61000	-3,33300	33,33000	4,03000	-3,33300	45,84500	4,03000	-3,33300
129	33,33000	4,03000	-3,33300	45,84500	4,03000	-1,33300	33,33000	4,44700	-2,91600	45,84500	4,44700	-2,91600
130	33,33000	4,44700	-2,91600	45,84500	4,44700	-2,91600	33,33000	4,44700	-1,66700	45,84500	4,44700	-1,66700
131	33,33000	4,44700	-1,66700	45,84500	4,44700	-1,66700	33,33000	4,44700	0,00000	45,84500	4,44700	0,00000
132	33,33000	4,44700	0,00000	45,84500	4,44700	0,00000	33,33000	3,61000	0,00000	45,84500	3,61000	0,00000
133	33,33000	3,61000	0,00000	45,84500	3,61000	0,00000	33,33000	2,77500	0,00000	45,84500	2,77500	0,00000
134	33,33000	2,77500	0,00000	45,84500	2,77500	0,00000	33,33000	2,56380	1,06190	45,84500	2,56380	1,06190
135	33,33000	2,56380	1,06190	45,84500	2,56380	1,06190	33,33000	1,96220	1,96220	45,84500	1,96220	1,96220
136	33,33000	1,96220	1,96220	45,84500	1,96220	1,96220	33,33000	1,06190	2,56380	45,84500	1,06190	2,56380
137	33,33000	1,06190	2,56380	45,84500	1,06190	2,56380	33,33000	0,00000	2,77500	45,84500	0,00000	2,77500

(i)

Figure 14.- Continued.

BODY PANEL CENTROID POINT COORDINATES, INCLINATION ANGLES AND AREAS

POINT	X CP	Y CP	Z CP	THETA RAD	DELTA RAD	AREA	THETA DEG	DELTA DEG
1	1,11133	,04297	-,27120	-2,98463	,24222	,11205	-171,007	13,87840
2	1,11133	,12467	-,24467	-2,67080	,24224	,11197	-153,003	13,87910
3	1,11133	,19417	-,19417	-2,35619	,24221	,11207	-135,000	13,87891
4	1,11133	,24467	-,12467	-2,04199	,24224	,11197	-116,997	13,87910
5	1,11133	,27120	-,04297	-1,72776	,24222	,11205	-98,993	13,87840
6	1,11133	,26743	,05320	-1,37473	,24060	,13965	-78,766	13,78560
7	1,11133	,22673	,15150	-,98177	,24062	,13965	-56,251	13,78644
8	1,11133	,15150	,22673	-,58903	,24062	,13965	-33,749	13,78644
9	1,11133	,05320	,26743	-,19607	,24060	,13964	-11,234	13,78560
10	3,62090	,18808	-,92975	-3,10471	,26233	,94176	-177,888	15,03018
11	3,63350	,48544	-,91569	-3,03091	,28394	,93047	-173,659	16,26868
12	3,68765	,74609	-,77459	-2,35619	,31722	1,26334	-135,000	18,17538
13	3,64634	,89083	-,46778	-1,67685	,27158	,94741	-96,075	15,56031
14	3,63589	,90490	-,15639	-1,60464	,24920	,97892	-92,054	14,27834
15	3,61109	,86851	,17278	-1,37446	,24037	1,11614	-78,751	13,77225
16	3,61104	,73629	,49200	-,98181	,24037	1,11595	-56,254	13,77220
17	3,61104	,49200	,73629	-,58898	,24037	1,11595	-33,746	13,77220
18	3,61109	,17278	,86851	-,19634	,24037	1,11614	-11,249	13,77225
19	7,78696	,33018	-1,87000	3,14159	,20277	3,24269	180,000	11,61811
20	7,78696	,96058	-1,87000	3,14159	,20277	3,24249	180,000	11,61811
21	7,50000	1,47900	-1,60250	-2,35619	,26290	3,05395	-135,000	15,06283
22	7,80727	1,74127	-1,09288	-1,57080	,17325	3,53796	-90,000	9,92625
23	7,80727	1,74127	-,36429	-1,57080	,17325	3,53796	-90,000	9,92625
24	7,71601	1,65951	,33013	-1,37438	,16998	3,34044	-78,746	9,73918
25	7,71609	1,40696	,94013	-,98180	,16998	3,34007	-56,253	9,73894
26	7,71609	,94013	1,40696	-,58899	,16998	3,34007	-33,747	9,73894
27	7,71601	,33013	1,65961	-,19641	,16998	3,34044	-11,254	9,73918
28	12,60788	,49324	-2,59167	3,14159	,13968	4,95324	180,000	8,00332
29	12,60788	1,47472	-2,59167	3,14159	,13968	4,95324	180,000	8,00332
30	12,50000	2,17050	-2,46800	-2,35619	,16962	2,99157	-135,000	9,71827
31	12,62948	2,39216	-1,70841	-1,57080	,10125	5,67657	-90,000	5,80134
32	12,62979	2,39219	-,56457	-1,57080	,10125	5,67909	-90,000	5,80136
33	12,58807	2,29715	,45693	-1,37446	,09933	4,66418	-78,749	5,69099
34	12,58899	1,94742	1,30123	-,98175	,09932	4,66417	-56,250	5,69085
35	12,58899	1,30123	1,94742	-,58905	,09932	4,66417	-33,750	5,69085
36	12,58897	,45693	2,29715	-,19636	,09933	4,66418	-11,251	5,69099
37	17,23944	,57193	-3,18208	3,14159	,06869	5,08112	180,000	3,93587
38	17,23944	1,71980	-3,18208	3,14159	,06869	5,08112	180,000	3,93587
39	17,21650	2,49550	-2,97200	-2,35619	,07118	2,62096	-135,000	4,07834
40	17,25741	2,70931	-2,07486	-1,57080	,03202	6,12733	-90,000	1,83470
41	17,25713	2,70930	-,69170	-1,57080	,03202	6,12955	-90,000	1,83470
42	17,23589	2,60170	,51749	-1,37407	,03141	4,67920	-78,731	1,79967
43	17,23591	2,20961	1,47371	-,98172	,03140	4,67949	-56,248	1,79929
44	17,23591	1,47371	2,20961	-,58908	,03140	4,67949	-33,752	1,79929
45	17,23589	,51749	2,60170	-,19633	,03141	4,67920	-11,249	1,79967
46	21,92000	,58850	-3,33300	3,14159	0,00000	5,86615	180,000	0,00000
47	21,92000	1,76450	-3,33300	3,14159	0,00000	5,86615	180,000	0,00000
48	21,92000	2,56450	-3,12450	-2,35619	0,00000	2,93310	-135,000	0,00000
49	21,92000	2,77500	-2,18700	-1,57080	0,00000	7,25209	-90,000	0,00000
50	21,92000	2,77510	-,72900	-1,57080	0,00000	7,25209	-90,000	0,00000
51	21,92000	2,66940	,53395	-1,37447	0,00000	5,38554	-78,751	0,00000
52	21,92000	2,26300	1,51295	-,98172	0,00000	5,38566	-56,248	0,00000
53	21,92000	1,51295	2,26300	-,58908	0,00000	5,38566	-33,752	0,00000
54	21,92000	,53395	2,66940	-,19633	0,00000	5,38554	-11,249	0,00000
55	[illegible]	[illegible]	[illegible]	3,14159	[illegible]	,92434	[illegible]	[illegible]

(j)

Figure 14.- Continued.

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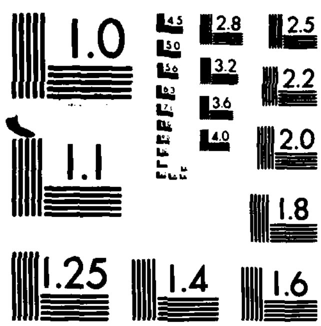

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

56	24.70000	1.70850	-1.33300	3.14159	0.00000	.07434	180.000	0.00000
57	24.70000	2.50850	-3.12850	-2.35619	0.00000	.00235	-135.000	0.00000
58	24.70091	2.77900	-2.23701	-1.57080	0.00000	1.00114	-90.000	0.00000
59	24.66031	2.77900	-1.10057	-1.57080	0.00000	.00019	-90.000	0.00000
60	24.70000	3.10250	-1.00105	3.14159	1.01072	1.23227	180.000	57.91025
61	24.70000	4.02850	-1.00105	3.14159	1.01072	1.23522	180.000	57.91025
62	24.67067	4.40700	-.76123	-1.57080	0.00000	.57500	-90.000	0.00000
63	24.70000	4.02850	-.30835	0.00000	.20067	.00001	0.000	19.05096
64	24.70008	3.10250	-.30835	0.00000	.20067	.07919	0.000	19.05096
65	24.74309	2.77900	-.16032	-1.57080	0.00000	.24175	-90.000	0.00000
66	24.70000	2.00000	.53095	-1.37467	0.00000	.00000	-70.751	0.00000
67	24.70000	2.26300	1.51205	-.98172	0.00000	.00002	-56.200	0.00000
68	24.70000	1.51205	2.26300	-.58000	0.00000	.00007	-33.752	0.00000
69	24.70000	.53095	2.00000	-.19033	0.00000	.00000	-11.209	0.00000
70	25.90000	.98050	-3.33300	3.14159	0.00000	.00500	180.000	0.00000
71	25.98541	1.97707	-3.33300	3.14159	0.00000	1.00220	180.000	0.00000
72	25.66140	2.83600	-3.19600	-2.35619	.37400	.23709	-135.000	21.43117
73	25.50000	2.77500	-2.03807	-1.57080	0.00000	.02575	-90.000	0.00000
74	25.50000	3.10250	-2.29150	3.14159	1.02932	1.21701	180.000	58.97957
75	25.50000	4.02850	-2.29150	3.14159	1.02932	1.21903	180.000	58.97957
76	25.69100	4.40700	-2.08333	-1.57080	0.00000	.00012	-90.000	0.00000
77	25.57050	4.40700	-.80200	-1.57000	0.00000	1.17713	-90.000	0.00000
78	25.50000	4.02850	-.10000	0.00000	.20020	.05000	0.000	14.90003
79	25.50000	3.10250	-.10000	0.00000	.20020	.00010	0.060	14.90003
80	25.66140	2.77500	-.00007	-1.57080	0.00000	.07517	-90.000	0.00000
81	25.90000	2.00000	.53095	-1.37467	0.00000	.01332	-70.751	0.00000
82	25.90000	2.26300	1.51205	-.98172	0.00000	.01300	-56.200	0.00000
83	25.50000	1.51205	2.26300	-.58000	0.00000	.01300	-33.752	0.00000
84	25.50000	.53095	2.00000	-.19033	0.00000	.01332	-11.209	0.00000
85	26.06735	.58050	-3.33300	3.14159	0.00000	.20510	180.000	0.00000
86	26.06735	1.97700	-3.33300	3.14159	0.00000	.99000	180.000	0.00000
87	26.07503	2.77500	-3.19600	-1.57080	0.00000	.05219	-90.000	0.00000
88	26.06735	3.10250	-3.12850	3.14159	1.03070	.00010	180.000	59.08014
89	26.09351	3.93970	-3.10140	3.14159	1.03020	.30507	180.000	59.08014
90	26.10007	4.30000	-3.05500	-2.35619	0.00000	.07300	-135.000	0.00000
91	26.06735	4.40700	-2.29150	-1.57080	0.00000	.31207	-90.000	0.00000
92	26.06735	4.40700	-.83350	-1.57080	0.00000	.01725	-90.000	0.00000
93	26.06735	4.02850	0.00000	0.00000	0.00000	.20050	0.000	0.00000
94	26.06735	3.10250	0.00000	0.00000	0.00000	.20090	0.000	0.00000
95	26.06735	2.00000	.53095	-1.37467	0.00000	.27100	-70.751	0.00000
96	26.06735	2.26300	1.51205	-.98172	0.00000	.27103	-56.200	0.00000
97	26.06735	1.51205	2.26300	-.58000	0.00000	.27103	-33.752	0.00000
98	26.06735	.53095	2.00000	-.19033	0.00000	.27100	-11.209	0.00000
99	27.02125	.58050	-3.33100	3.14159	0.00000	3.00050	180.000	0.00000
100	27.02125	1.97700	-3.33300	3.14159	0.00000	5.10807	180.000	0.00000
101	27.02125	3.10250	-3.33300	3.14159	0.00000	2.72001	180.000	0.00000
102	27.02125	3.82000	-3.33300	3.14159	0.00000	1.30019	180.000	0.00000
103	27.02125	4.24850	-3.12850	-2.35619	0.00000	1.92104	-135.000	0.00000
104	27.02125	4.40700	-2.29150	-1.57080	0.00000	4.00062	-90.000	0.00000
105	27.02125	4.40700	-.83350	-1.57080	0.00000	5.03025	-90.000	0.00000
106	27.02125	4.02850	0.00000	0.00000	0.00000	2.72853	0.000	0.00000
107	27.02125	3.10250	0.00000	0.00000	0.00000	2.72001	0.000	0.00000
108	27.02125	2.00000	.53095	-1.37467	0.00000	3.57000	-70.751	0.00000
109	27.02125	2.26300	1.51205	-.98172	0.00000	3.52721	-56.200	0.00000
110	27.02125	1.51205	2.26300	-.58000	0.00000	3.52721	-33.752	0.00000
111	27.02125	.53095	2.00000	-.19033	0.00000	3.92000	-11.209	0.00000
112	31.50000	.58050	-3.33300	3.14159	0.00000	4.57052	180.000	0.00000
113	31.50000	1.97700	-3.33300	3.14159	0.00000	4.19200	180.000	0.00000
114	31.50000	3.10250	-3.33300	3.14159	0.00000	3.23000	180.000	0.00000
115	31.50000	[illegible]	[illegible]	3.14159	0.00000	1.02900	180.000	0.00000

(k)

Figure 14.- Continued.

116	31.30000	0.23850	-3.12450	-2.35610	0.00000	2.29610	-135.000	0.00000
117	31.30000	0.00700	-2.29150	-1.57000	0.00000	0.00012	-90.000	0.00000
118	31.30000	0.00700	-.03350	-1.57000	0.00000	0.00700	-90.000	0.00000
119	31.30000	0.02850	0.00000	0.00000	0.00000	3.20750	0.000	0.00000
120	31.30000	3.10290	0.00000	0.00000	0.00000	3.23000	0.000	0.00000
121	31.30000	2.00000	.51095	-1.37007	0.00000	0.20007	-70.751	0.00000
122	31.30000	2.20300	1.51265	-.90177	0.00000	0.20128	-50.200	0.00000
123	31.30000	1.51205	2.20300	-.50000	0.00000	0.20128	-33.752	0.00000
124	31.30000	.53095	2.00000	-.19033	0.00000	0.20007	-11.240	0.00000
125	30.98750	.50050	-3.33300	3.14190	0.00000	10.75510	180.000	0.00000
126	30.98750	1.97700	-3.33300	3.14190	0.00000	10.07300	180.000	0.00000
127	30.98750	3.10290	-3.33300	3.14190	0.00000	10.05001	180.000	0.00000
128	30.98750	3.92000	-3.33300	3.14190	0.00000	5.25010	180.000	0.00000
129	30.98750	0.23950	-3.12450	-2.35610	0.00000	7.30003	-135.000	0.00000
130	30.98750	0.00700	-2.29150	-1.57000	0.00000	15.03120	-90.000	0.00000
131	30.98750	0.00700	-.03350	-1.57000	0.00000	20.00251	-90.000	0.00000
132	30.98750	0.02850	0.00000	0.00000	0.00000	10.07500	0.000	0.00000
133	30.98750	3.10290	0.00000	0.00000	0.00000	10.05003	0.000	0.00000
134	30.98750	2.00000	.51095	-1.37007	0.00000	13.50000	-70.751	0.00000
135	30.98750	2.20300	1.51265	-.90177	0.00000	13.95120	-50.200	0.00000
136	30.98750	1.51205	2.20300	-.50000	0.00000	13.95120	-33.752	0.00000
137	30.98750	.53095	2.00000	-.19033	0.00000	16.50000	-11.240	0.00000

(l)

Figure 14.- Continued.

```
FUSELAGE INTERFERENCE SHELL DATA

     9 RINGS OF VELOCITY PANELS ARE TO BE LAID OUT ON THE FUSELAGE FROM X= 0 FEET TO X= 115.00100 FEET
        THERE ARE 14 PANELS IN EACH RING ON THE LEFT HALF OF THE FUSELAGE.
        TOTAL NUMBER OF PANELS IS [illegible]


Y-Z COORDINATES OF BODY INTERFERENCE PANELS  XRIN = 24.000

          I        YCB         ZCB
          1     0.00000    -3.33300
          2     1.17900    -3.33300
          3     2.77500    -3.33300
          4     3.61000    -3.33300
          5     4.05800    -3.33300
          6     4.44700    -2.91600
          7     4.44700    -1.66700
          8     4.44700     0.00000
          9     3.61000     0.00000
         10     2.77500     0.00000
         11     2.56380     1.06190
         12     1.96220     1.96220
         13     1.06190     2.56380
         14     0.00000     2.77500


    VELOCITY ON BODY                                                                            ** SOLVE **

MACHO 1.500   ALPHAO 5.000   PHIRO 0.000

   PANEL    SOURCE      NORMAL BC
    NO.    STRENGTH     VELOCITY
      1     .34034      .32252
      2     .32730      .31435
      3     .30438      .30079
      4     .26687      .27737
      5     .22831      .25210
      6     .18631      .22088
      7     .13810      .19037
      8     .09646      .16702
      9     .07608      .15034
     10     .39194      .34266
     11     .36512      .34223
     12     .32202      .34029
     13     .26367      .27612
     14     .22382      .24472
     15     .18843      .22064
     16     .13116      .19811
     17     .09208      .16677
     18     .07208      .15013
     19     .41699      .28900
     20     .37626      .28590
     21     .28831      .31[illegible]
     22     .05682      .17171
     23     .13076      .17112
     24     .12296      .15176
     25   [illegible]   [illegible]
```

(m)

Figure 14.- Continued.

26	.05718	.07909E-01
27	.01638	.04272E-01
28	.37527	.22501
29	.37120	.22501
30	.22409	.22091
31	-.01908	.10870
32	.00276	.10078
33	.05420	.81000E-01
34	-.00050	.90001E-01
35	-.05009	.20073E-01
36	-.00511	.13720E-01
37	.32906	.15533
38	.35401	.15533
39	.15930	.13232
40	-.00009	.31000E-01
41	-.01230	.31490E-01
42	-.01745	.10200E-01
43	-.00082	-.17121E-01
44	-.14305	-.01151E-01
45	-.17298	-.94197E-01
46	.10638	.87150E-01
47	.20193	.87150E-01
48	.00201	.01020E-01
49	-.00816	.10000E-15
50	-.00760	.10000E-15
51	-.01015	-.17091E-01
52	-.00769	-.60023E-01
53	-.19071	-.72000E-01
54	-.10116	-.85001E-01
55	.20198	.87150E-01
56	.24307	.87150E-01
57	.07470	.01020E-01
58	-.00000	.10000E-15
59	-.03021	.10000E-15
60	.09378	0.
61	.00320	0.
62	-.01140	.10000E-15
63	.19400	.18130
64	.13000	.18130
65	.06701	.10000E-15
66	-.02717	-.17001E-01
67	-.19527	-.00023E-01
68	-.17091	-.72000E-01
69	-.20250	-.05001E-01
70	.20900	.87150E-01
71	.29100	.87150E-01
72	.30211	.02130
73	-.18072	.10000E-15
74	.00277	0.
75	.00109	0.
76	-.00000	.10000E-15
77	-.05700	.10000E-15
78	.17001	.17200
79	.10273	.17200
80	.17012	.10000E-15
81	-.02070	-.17001E-01
82	-.19037	-.60023E-01
83	-.10019	-.72000E-01
84	-.04079	-.05001E-01
85	.25102	.87150E-01

(n)

Figure 14.- Continued.

86	.24301	.871540E-01
87	-.25494	.149408E-15
88	.03270	.00000
89	.03222	.00000
90	.11456	.610408E-01
91	-.04593	.149408E-15
92	-.07615	.149408E-15
93	-.22633	-.871540E-01
94	-.28413	-.871540E-01
95	.02050	-.170081E-01
96	-.11109	-.684235E-01
97	-.10692	-.724000E-01
98	-.21350	-.854081E-01
99	.25050	.871540E-01
100	.20525	.871540E-01
101	.19371	.871540E-01
102	.21120	.871540E-01
103	-.00442	.610408E-01
104	-.10212	.149408E-15
105	.17101	.149408E-15
106	-.40150	-.871540E-01
107	-.42013	-.871540E-01
108	-.20171	-.170081E-01
109	-.08401	-.684235E-01
110	-.10332	-.724000E-01
111	-.10790	-.854081E-01
112	.40400	.871540E-01
113	.32098	.871540E-01
114	.34490	.871540E-01
115	.30402	.871540E-01
116	.13214	.610408E-01
117	-.07953	.149408E-15
118	.09090	.149408E-15
119	-.29022	-.871540E-01
120	-.34050	-.871540E-01
121	-.09004	-.170081E-01
122	-.13400	-.684235E-01
123	-.12215	-.724000E-01
124	.02177	-.854081E-01
125	.20302	.871540E-01
126	.27722	.871540E-01
127	.20334	.871540E-01
128	.20072	.871540E-01
129	.06007	.610408E-01
130	-.12791	.149408E-15
131	.04778	.149408E-15
132	-.30270	-.871540E-01
133	-.39713	-.871540E-01
134	-.13520	-.170081E-01
135	-.09029	-.684235E-01
136	-.10106	-.724000E-01
137	-.20049	-.854081E-01

FUSELAGE SHOCK WAVE SHAPE

MODIFIED SHOCK LOCATIONS PHIS = 0.000 ** [illegible] **

N I X Y R ML BETA DS/DX RHO UVWSQ

(o)

Figure 14.- Continued.

1	0.000	0.000	0.00000	0.00000	1.35906	1.09610			
2	7.316	6.675	.07309	.14901	1.35906	1.09610	1.09610	8.82600	.77530
3	12.194	11.125	.02920	.08218	1.35906	1.09610	1.09610	4.49760	.06103
4	22.143	20.025	.04032	.05931	1.38397	1.13963	1.11706	3.31323	.09073
5	32.457	28.925	.05360	.04872	1.40029	1.17017	1.15990	2.49706	.02194
6	42.570	37.025	.05246	.12330	1.40029	1.09610	1.13710	7.15757	.02140
7	52.353	46.725	.03050	.10677	1.40029	1.09610	1.09610	6.34530	.04924
8	73.075	64.525	.04028	.03202	1.43020	1.23443	1.10526	1.76115	.93085

MODIFIED SHOCK LOCATION: PHIS = 45.000 ** HAMUCK **

N	X	R	U	W	ML	BETA	DX/DR	DNU	UWBQ
1	0.000	0.000	0.00000	0.00000	1.36025	1.05828			
2	7.064	6.675	.93218	.18048	1.36025	1.05828	1.05828	5.96036	.87863
3	11.773	11.125	.93453	.07390	1.36025	1.05828	1.05828	4.29600	.87828
4	21.372	20.025	.95127	.09329	1.39346	1.09970	1.07849	3.03940	.08747
5	31.296	28.925	.95967	.04378	1.41610	1.13153	1.11512	2.47380	.02230
6	41.376	37.025	.95541	.00326	1.41933	1.13351	1.13252	2.43020	.01046
7	61.066	55.025	.96797	.03256	1.43731	1.16076	1.15112	1.81733	.03706
8	82.022	73.425	.97420	.02716	1.44009	1.18590	1.17732	1.50923	.04972

MODIFIED SHOCK LOCATION: PHIS = 90.000 ** BBMOCK **

N	X	R	U	W	ML	BETA	DX/DR	DNU	UWBQ
1	0.000	0.000	0.00000	0.00000	1.39487	.97246			
2	6.491	6.675	.93369	.09469	1.39487	.97246	.97246	5.85816	.00040
3	10.019	11.125	.95078	.06022	1.39487	.97246	.97246	3.64432	.00706
4	19.562	20.025	.96274	.04391	1.40876	.99228	.98237	2.62367	.02882
5	37.900	37.025	.97327	.03010	1.43871	1.03635	1.01351	1.77751	.04817
6	56.085	55.025	.97480	.02720	1.44677	1.04277	1.03056	1.60630	.05898
7	93.570	91.225	.98210	.02010	1.45994	1.06316	1.05296	1.17981	.06502
8	109.788	102.425	.96067	.01565	1.47669	1.07759	1.07036	.87546	.07375

FUSELAGE INLET SHOCK SHAPE ** INLSHK **

INLET GEOMETRY
LEADING EDGE XINLT = 24.407 YINLT = 4.447 ZINLT = 4.417
TRAILING EDGE XINLTE = 24.193 YINLTE = 8.447 ZINLTE = 43.333
MASS FLOW RATIO (MVIVAR) .873 XCLOSD = 25.942

MODIFIED SHOCK LOCATION: RADIAL ANGLE (PHINL) = 0.000
CENTROID AT: XINLT = 24.407 YINL = 0.000 ZINLT = 4.417

N	X	R	U	W	ML	BETA	DX/DR	DNU	UWBQ
1	0.000	0.000	0.00000	0.00000	1.08179	.10811			
2	1.007	2.501	0.00000	0.00000	1.08179	.10811			
3	1.535	5.015	0.00000	0.00000	1.08179	.10811			
4	3.020	4.725	.90330	.06008	1.41036	1.21930	1.21930	2.81607	.81697
5	5.066	6.635	.97418	.09006	1.39063	1.15083	1.10947	3.13601	.76067
6	7.590	8.144	.90930	.06946	1.37653	1.12320	1.13702	3.47296	.75061
7	9.491	9.896	.96393	.07079	1.36196	1.10124	1.11220	3.01602	.74910

(p)

Figure 14.- Continued.

8	13.202	13.274	.05171	.07430	1.34182	1.00914	1.00517	4.00726	.73516

MODIFIED SHOCK LOCATION: RADIAL ANGLE (PHINL) = 0.000
CENTROID AT: XINLT = 24.607 YINL = 6.667 ZINLT = 0.617

N	X	R	U	W	ML	BETA	DX/DR	DNU	UVRSU
1	0.000	0.000	0.00000	0.00000	1.00170	.10811			
2	1.097	2.501	0.00000	0.00000	1.00170	.10811			
3	1.535	3.015	0.00000	0.00000	1.00170	.10811			
4	3.390	4.725	.07034	.07305	1.35530	1.00901	1.00901	4.09500	.76137
5	5.205	6.435	.04708	.08705	1.31963	1.02474	1.05710	5.00771	.71570
6	6.925	8.144	.02888	.09586	1.29837	.90712	1.00503	5.00800	.69233
7	8.612	9.854	.02708	.09608	1.29709	.90624	.90008	5.02142	.69136
8	12.106	13.274	.05472	.08087	1.33725	1.05705	1.02144	4.58348	.73528

MODIFIED SHOCK LOCATION: RADIAL ANGLE (PHINL) = 90.000
CENTROID AT: XINLT = 24.607 YINL = 6.667 ZINLT = 0.617

N	X	R	U	W	ML	BETA	DX/DR	DNU	UVRSU
1	0.000	0.000	0.00000	0.00000	1.09382	.08709			
2	1.018	1.710	.97467	.92100	1.05790	1.00100	1.00100	1.22510	.94225
3	3.602	3.419	.97687	.91587	1.46990	1.07731	1.00916	.40092	.95449
4	7.366	6.839	.98203	.91878	1.07861	1.00917	1.00328	.02776	.96508
5	14.020	13.678	.08731	.08782	1.08487	1.09765	1.09341	.00525	.97084
6	29.079	27.356	.09087	.00940	1.08932	1.10367	1.10006	.31509	.98105
7	60.128	54.712	.09369	.00382	1.09287	1.10791	1.10579	.22270	.98703

(q)

Figure 14.- Continued.

```
WING INPUT DATA

    LOCATION OF WING ROOT CHORD LEADING EDGE RELATIVE TO FUSELAGE NOSE
            XP = -27.51100 FEET
            ZP =   0.00000 FEET
    INCIDENCE ANGLE OF WING ROOT CHORD RELATIVE TO FUSELAGE AXIS
            IW =    0.00 DEGREES
    LENGTH OF WING ROOT CHORD
            CRW =  13.00100 FEET
    WING SEMISPAN
            SSPAN =  20.00000 FEET

     72 U-VELOCITY PANELS ARE TO BE LAID OUT ON EACH WING PANEL
         8 CHORDWISE ROWS WITH  9 IN EACH ROW

    SPANWISE LOCATIONS OF PANEL SIDE EDGES AND SWEEP ANGLES AND
        DIHEDRAL ANGLE OF WING SECTION TO THE RIGHT
```

I	SPANWISE LOCATION FEET	LE SWEEP DEGREES	TE SWEEP DEGREES	DIHEDRAL DEGREES
1	-4.44700	0.00000	0.00000	0.00000
2	-5.55500	40.00000	30.75000	0.00000
3	-6.66700	40.00000	30.75000	0.00000
4	-8.88900	40.00000	30.75000	0.00000
5	-11.11200	40.00000	30.75000	0.00000
6	-13.33300	40.00000	30.75000	0.00000
7	-15.55500	40.00000	30.75000	0.00000
8	-17.77800	40.00000	30.75000	0.00000
9	-20.00000	40.00000	30.75000	0.00000

```
     50 THICKNESS PANELS ARE TO BE LAID OUT ON EACH WING PANEL
         1 CHORDWISE ROWS WITH 50 IN EACH ROW
         WING THICKNESS OPTION, NWTS= 1

    SPANWISE LOCATIONS OF PANEL SIDE EDGES AND SWEEP ANGLES AND
        DIHEDRAL ANGLE OF WING SECTION TO THE RIGHT
```

I	SPANWISE LOCATION FEET	LE SWEEP DEGREES	TE SWEEP DEGREES	DIHEDRAL DEGREES
1	-4.44700	0.00000	0.00000	0.00000
2	-20.00000	40.00000	30.75000	0.00000

(r)

Figure 14.- Continued.

```
PYLON INPUT DATA

    LEADING EDGE OF PYLON ROOT CHORD IS AT X0  =4.53000 FEET (MEASURED FROM LOCAL WING LEADING EDGE)
    SPANWISE LOCATION IS Y0   0.00000 FEET
    ROOTCHORD =   4.44200 FEET
    HEIGHT =    .75000 FEET

      4 U-VELOCITY PANELS ARE TO BE LAID OUT ON THE PYLON
          2 CHORDWISE ROWS WITH  2 IN EACH ROW

    SPANWISE LOCATIONS OF PANEL SIDE EDGES AND SWEEP ANGLES OF
        PYLON SECTION TO THE RIGHT

        K          Z        LE SWEEP  TE SWEEP
                 FEET       DEGREES   DEGREES
        1        3.33300    0.00000   0.00000
        2        3.70830    0.00000   0.00000
        3        4.08330    0.00000   0.00000

     40 THICKNESS PANELS ARE TO BE LAID OUT ON THE PYLON
          1 CHORDWISE ROWS WITH 40 IN EACH ROW
          PYLON THICKNESS OPTION, NUMTPO 1

    SPANWISE LOCATIONS OF PANEL SIDE EDGES AND SWEEP ANGLES OF
        PYLON SECTION TO THE RIGHT

        K          Z        LE SWEEP  TE SWEEP
                 FEET       DEGREES   DEGREES
        1        3.33300    0.00000   0.00000
        2        4.08330    0.00000   0.00000
```

(s)

Figure 14.- Continued.

INPUT VALUES OF THE LOCAL SURFACE SLOPE OF THE THICKNESS
DISTRIBUTION, FOR EACH CHORDWISE ROW. THE FIRST VALUE
IS FOR THE PANEL NEAREST THE LEADING EDGE

WING THICKNESS DATA

NW	SLOPES							
1	.20900	.19000	.13700	.11400	.09700	.08400	.07500	.06600
	.05900	.05200	.04700	.04100	.03600	.03100	.02600	.02100
	.01600	.01100	.00700	.00200	-.00200	-.00600	-.01000	-.01400
	-.01800	-.02200	-.02500	-.02900	-.03300	-.03700	-.04100	-.04500
	-.04800	-.05200	-.05500	-.05900	-.06100	-.06400	-.06600	-.06700
	-.06700	-.06700	-.06700	-.06700	-.06700	-.06700	-.06700	-.06700
	-.06700	-.06700						

PYLON THICKNESS DATA

NW	SLOPES							
1	.09629	.09629	.09629	.09629	.09629	.09629	.09629	.09629
	.09629	.09629	.09629	.09629	.09629	.09629	.09629	.09629
	.09629	.09629	0.00000	0.00000	0.00000	0.00000	-.09629	-.09629
	-.09629	-.09629	-.09629	-.09629	-.09629	-.09629	-.09629	-.09629
	-.09629	-.09629	-.09629	-.09629	-.09629	-.09629	-.09629	-.09629

(t)

Figure 14.- Continued

STORE INPUT DATA

STORE NO	SHAPE NO	LENGTH FT	MAXIMUM RADIUS FT	STORE LOCATION RELATIVE TO LOCAL WING CHORD LEADING EDGE X, FT	Y, FT	Z, FT	INCIDENCE ANGLE DEG	ROLL ANGLE DEG
10	52	10.00000	1.25000	.05550	0.00000	4.70830	0.00000	0.00000

DATA FOR STORE SHAPE NO. 52

ELLIPTIC STORE IS MODELLED USING WOODWARD SOURCE PANEL OPTION

(u)

Figure 14.- Continued.

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2 TO 1  ELLIPTIC OGIVE STORE, 8E = EXTERNAL SHAPE DEFINED BY FUSRY AND A/B                    ** GEOM   **

PANEL SYMMETRY OPTION                         (IXZSYM) =     1
                                                         INPUT GEOM SHOCK VEL SOLN
PRINT CONTROLS (NO=0,YES=+)                    (IPRT) =     1     1     1     0     1
U,V,W CALCULATION (YES=0,NO=1)                 (IUVW) =     0
NUMBER OF SHOCK SHAPES                       (NSHOCK) =     1
MAXIMUM NUMBER OF POINTS IN SHAPE            (MAXSHK) =     8
OPEN INLET PANELS (0=NO, 1=25 PANELS)        (NINLET) =     0
CLOSED INLET PANELS                          (NINBLK) =     0
INLET PANELS IN FIELD VELOCITY CALC          (NINVEL) =     0

X=LOC FOR INTERFERENCE SHELL GEOMETRY          (XRIP) = 0.
NOSE SHOULDER LOCATION FOR SHOCK             (XSHLDR) =  4.1667
RATIO FOR SHOCK ROTATION WITH ALPHA          (FALPHA) =  .57500

             EXTERNAL GEOMETRY OPTIONS AND SHAPE
READ REF. AREA CARD (NO=0,YES=1)                   (J0) =     0
EXTERNAL GEOMETRY TYPE                             (J2) =    -5
READ Z=CENTERLINE (NO=-1, YES=0)                   (J6) =    -1
NUMBER OF BODY SEGMENTS                          (NFUS) =     1
                                               SEGMENT     (1)   (2)   (3)   (4)   (5)
NUMBER OF GEOMETRY CORNER MERIDIANS             (NRADX) =    19     0     0     0     0
NUMBER OF CROSS SECTION AXIALLY                 (NFORX) =    23     0     0     0     0


        VEHICLE GEOMETRY DEFINITION                                                            ** CONFIG **
REFERENCE AREA (J0,GT,0)     REFA=  1.00000

NFU     XFUS = BODY X=STATIONS
  1     0.0000    .2000    .4000     .6000     .8000    1.0000    1.2000    1.4000    1.6000    1.8000
        2.0000   2.2000   2.4000    2.6000    2.8000    3.0000    3.2000    3.4000    3.6000    3.8000
        4.0000   4.1670  10.0000

NFU     FUSRY = ELLIPTIC BODY HORIZ SEMI=MAJOR AXES
  1     0.0000    .1270    .2463     .3570     .4601     .5557     .6444     .7262     .8015     .8705
         .9332    .9900   1.0409    1.0861    1.1256    1.1595    1.1880    1.2110    1.2287    1.2411
        1.2487   1.2500   1.2500

NFU     ELLIPTIC RATIO (VERT/HORIZ AXES)
  1      .5000   0.0000   0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
        0.0000   0.0000   0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
        0.0000   0.0000   0.0000

NFU     FUSAZ = ELLIPTIC BODY VERT SEMI=MINOR AXES
  1     0.0000    .0635    .1232     .1785     .2301     .2779     .3222     .3631     .4008     .4353
         .4666    .4950    .5205     .5431     .5628     .5798     .5940     .6055     .6144     .6206
         .6244    .6250    .6250

        CROSS SECTIONAL AREAS
MAXIMUM AREA =  2.4544          SHOULDER AREA = 0.              X=SHOULDER =  4.1667        BODY LENGTH =  10.000
```

(v)

Figure 14.- Continued.

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ELLIPTIC STORE - MERIDIONAL SPACING MATCHES INTERDIGITATED TAIL ANGLES                    ** GEOM **

          REVISED PANELING GEOMETRY OPTIONS AND SHAPE
   READ REFERENCE LENGTH CARD (0=NO, 1=YES)     (KR) =     1
   NUMBER OF BODY PANELING SEGMENTS            (NPHB) =     1
                                              SEGMENT    (1)  (2)  (3)  (4)  (5)
   NUMBER OF PANEL CORNERS RADIALLY           (NRADX) =    5    0    0    0    0
   NUMBER OF PANEL CROSS SECTIONS AXIALLY     (NFORX) =   19    0    0    0    0

       PANEL REFERENCE LENGTHS
  REFAR      REFD       REFL       REFX       REFZ
  2.054      1.760     10.000      5.000      0.000

 IPHB    1
PHIKB 0.          55.000      90.000      125.00      180.00

 IPHB    1
 XJB 0.           .80000      1.0000      2.0000      3.0000      3.5000      4.0000      4.5000      5.0000      5.5000
     5.8330       6.5000      7.0000      7.5000      8.0000      8.3330      8.7500      9.2000      10.000
```

(w)

Figure 14.- Continued.

BODY PANEL CORNER POINT COORDINATES   ** BODPAN **

1 AND 3 INDICATE BODY PANEL LEADING-EDGE POINTS, 2 AND 4 INDICATE TRAILING-EDGE POINTS

PANEL	X 1	Y 1	Z 1	X 2	Y 2	Z 2	X 3	Y 3	Z 3	X 4	Y 4	Z 4
1	0.00000	0.00000	0.00000	.80000	.00000	-.23005	0.00000	0.00000	0.00000	.80000	.26738	-.18722
2	0.00000	0.00000	0.00000	.80000	.26738	-.18722	0.00000	0.00000	0.00000	.80000	.46010	.00000
3	0.00000	0.00000	0.00000	.80000	.46010	.00000	0.00000	0.00000	0.00000	.80000	.26738	.18722
4	0.00000	0.00000	0.00000	.80000	.26738	.18722	0.00000	0.00000	0.00000	.80000	-.00000	.23005
5	0.00000	0.00000	0.00000	.80000	-.00000	.23005	0.00000	0.00000	0.00000	.80000	-.26738	.18722
6	0.00000	0.00000	0.00000	.80000	-.26738	.18722	0.00000	0.00000	0.00000	.80000	-.46010	.00000
7	0.00000	0.00000	0.00000	.80000	-.46010	.00000	0.00000	0.00000	0.00000	.80000	-.26738	-.18722
8	0.00000	0.00000	0.00000	.80000	-.26738	-.18722	0.00000	0.00000	0.00000	.80000	-.00000	-.23005
9	.80000	.00000	-.23005	1.60000	.00000	-.40875	.80000	.26738	-.18722	1.60000	.46577	-.32614
10	.80000	.26738	-.18722	1.60000	.46577	-.32614	.80000	.46010	.00000	1.60000	.80150	.00000
11	.80000	.46010	.00000	1.60000	.80150	.00000	.80000	.26738	.18722	1.60000	.46577	.32614
12	.80000	.26738	.18722	1.60000	.46577	.32614	.80000	-.00000	.23005	1.60000	-.00000	.40875
13	.80000	-.00000	.23005	1.60000	-.00000	.40875	.80000	-.26738	.18722	1.60000	-.46577	.32614
14	.80000	-.26738	.18722	1.60000	-.46577	.32614	.80000	-.46010	.00000	1.60000	-.80150	.00000
15	.80000	-.46010	.00000	1.60000	-.80150	.00000	.80000	-.26738	-.18722	1.60000	-.46577	-.32614
16	.80000	-.26738	-.18722	1.60000	-.46577	-.32614	.80000	-.00000	-.23005	1.60000	-.00000	-.40875
17	1.60000	.00000	-.40875	2.40000	.00000	-.52045	1.60000	.46577	-.32614	2.40000	.60489	-.42355
18	1.60000	.46577	-.32614	2.40000	.60489	-.42355	1.60000	.80150	.00000	2.40000	1.00090	.00000
19	1.60000	.80150	.00000	2.40000	1.00090	.00000	1.60000	.46577	.32614	2.40000	.60489	.42355
20	1.60000	.46577	.32614	2.40000	.60489	.42355	1.60000	-.00000	.40875	2.40000	-.00000	.52045
21	1.60000	-.00000	.40875	2.40000	-.00000	.52045	1.60000	-.46577	.32614	2.40000	-.60489	.42355
22	1.60000	-.46577	.32614	2.40000	-.60489	.42355	1.60000	-.80150	.00000	2.40000	-1.00090	.00000
23	1.60000	-.80150	.00000	2.40000	-1.00090	.00000	1.60000	-.46577	-.32614	2.40000	-.60489	-.42355
24	1.60000	-.46577	-.32614	2.40000	-.60489	-.42355	1.60000	-.00000	-.40875	2.40000	-.00000	-.52045
25	2.40000	.00000	-.52045	3.00000	.00000	-.57975	2.40000	.60489	-.42355	3.00000	.67301	-.47101
26	2.40000	.60489	-.42355	3.00000	.67301	-.47101	2.40000	1.00090	.00000	3.00000	1.15950	.00000
27	2.40000	1.00090	.00000	3.00000	1.15950	.00000	2.40000	.60489	.42355	3.00000	.67301	.47101
28	2.40000	.60489	.42355	3.00000	.67301	.47101	2.40000	-.00000	.52045	3.00000	-.00000	.57975
29	2.40000	-.00000	.52045	3.00000	-.00000	.57975	2.40000	-.60489	.42355	3.00000	-.67301	.47101
30	2.40000	-.60489	.42355	3.00000	-.67301	.47101	2.40000	-1.00090	.00000	3.00000	-1.15950	.00000
31	2.40000	-1.00090	.00000	3.00000	-1.15950	.00000	2.40000	-.60489	-.42355	3.00000	-.67301	-.47101
32	2.40000	-.60489	-.42355	3.00000	-.67301	-.47101	2.40000	-.00000	-.52045	3.00000	-.00000	-.57975
33	3.00000	.00000	-.57975	3.50000	.00000	-.60993	3.00000	.67301	-.47101	3.50000	.70088	-.49637
34	3.00000	.67301	-.47101	3.50000	.70088	-.49637	3.00000	1.15950	.00000	3.50000	1.21985	.00000
35	3.00000	1.15950	.00000	3.50000	1.21985	.00000	3.00000	.67301	.47101	3.50000	.70088	.49637
36	3.00000	.67301	.47101	3.50000	.70088	.49637	3.00000	-.00000	.57975	3.50000	-.00000	.60993
37	3.00000	-.00000	.57975	3.50000	-.00000	.60993	3.00000	-.67301	.47101	3.50000	-.70088	.49637
38	3.00000	-.67301	.47101	3.50000	-.70088	.49637	3.00000	-1.15950	.00000	3.50000	-1.21985	.00000
39	3.00000	-1.15950	.00000	3.50000	-1.21985	.00000	3.00000	-.67301	-.47101	3.50000	-.70088	-.49637
40	3.00000	-.67301	-.47101	3.50000	-.70088	-.49637	3.00000	-.00000	-.57975	3.50000	-.00000	-.60993
41	3.50000	.00000	-.60993	4.00000	.00000	-.62810	3.50000	.70088	-.49637	4.00000	.72536	-.50790
42	3.50000	.70088	-.49637	4.00000	.72536	-.50790	3.50000	1.21985	.00000	4.00000	1.24820	.00000
43	3.50000	1.21985	.00000	4.00000	1.24820	.00000	3.50000	.70088	.49637	4.00000	.72536	.50790
44	3.50000	.70088	.49637	4.00000	.72536	.50790	3.50000	-.00000	.60993	4.00000	-.00000	.62810
45	3.50000	-.00000	.60993	4.00000	-.00000	.62810	3.50000	-.70088	.49637	4.00000	-.72536	.50790
46	3.50000	-.70088	.49637	4.00000	-.72536	.50790	3.50000	-1.21985	.00000	4.00000	-1.24820	.00000
47	3.50000	-1.21985	.00000	4.00000	-1.24820	.00000	3.50000	-.70088	-.49637	4.00000	-.72536	-.50790
48	3.50000	-.70088	-.49637	4.00000	-.72536	-.50790	3.50000	-.00000	-.60993	4.00000	-.00000	-.62810
49	4.00000	.00000	-.62810	4.50000	.00000	-.62500	4.00000	.72536	-.50790	4.50000	.72041	-.50063
50	4.00000	.72536	-.50790	4.50000	.72041	-.50063	4.00000	1.24820	.00000	4.50000	1.25000	.00000
51	4.00000	1.24820	.00000	4.50000	1.25000	.00000	4.00000	.72536	.50790	4.50000	.72041	.50063
52	4.00000	.72536	.50790	4.50000	.72041	.50063	4.00000	-.00000	.62810	4.50000	-.00000	.62500
53	4.00000	-.00000	.62810	4.50000	-.00000	.62500	4.00000	-.72536	.50790	4.50000	-.72041	.50063

(x)

Figure 14.- Continued.

54	4.00000	-.72536	.50790	4.50000	-.72041	.50063	4.00000	-1.24820	.00000	4.50000	-1.25000	.00000
55	4.00000	-1.24820	.00000	4.50000	-1.25000	.00000	4.00000	-.72536	-.50790	4.50000	-.72041	-.50063
56	4.00000	-.72536	-.50790	4.50000	-.72041	-.50063	4.00000	-.00000	-.62510	4.50000	-.00000	-.62500
57	4.50000	.00000	-.62500	5.00000	.00000	-.62500	4.50000	.72041	-.50063	5.00000	.72041	-.50063
58	4.50000	.72041	-.50063	5.00000	.72041	-.50063	4.50000	1.25000	.00000	5.00000	1.25000	.00000
59	4.50000	1.25000	.00000	5.00000	1.25000	.00000	4.50000	.72041	.50063	5.00000	.72041	.50063
60	4.50000	.72041	.50063	5.00000	.72041	.50063	4.50000	-.00000	.62500	5.00000	-.00000	.62500
61	4.50000	-.00000	.62500	5.00000	-.00000	.62500	4.50000	-.72041	.50063	5.00000	-.72041	.50063
62	4.50000	-.72041	.50063	5.00000	-.72041	.50063	4.50000	-1.25000	.00000	5.00000	-1.25000	.00000
63	4.50000	-1.25000	.00000	5.00000	-1.25000	.00000	4.50000	-.72041	-.50063	5.00000	-.72041	-.50063
64	4.50000	-.72041	-.50063	5.00000	-.72041	-.50063	4.50000	-.00000	-.62500	5.00000	-.00000	-.62500
65	5.00000	.00000	-.62500	5.50000	.00000	-.62500	5.00000	.72041	-.50063	5.50000	.72041	-.50063
66	5.00000	.72041	-.50063	5.50000	.72041	-.50063	5.00000	1.25000	.00000	5.50000	1.25000	.00000
67	5.00000	1.25000	.00000	5.50000	1.25000	.00000	5.00000	.72041	.50063	5.50000	.72041	.50063
68	5.00000	.72041	.50063	5.50000	.72041	.50063	5.00000	-.00000	.62500	5.50000	-.00000	.62500
69	5.00000	-.00000	.62500	5.50000	-.00000	.62500	5.00000	-.72041	.50063	5.50000	-.72041	.50063
70	5.00000	-.72041	.50063	5.50000	-.72041	.50063	5.00000	-1.25000	.00000	5.50000	-1.25000	.00000
71	5.00000	-1.25000	.00000	5.50000	-1.25000	.00000	5.00000	-.72041	-.50063	5.50000	-.72041	-.50063
72	5.00000	-.72041	-.50063	5.50000	-.72041	-.50063	5.00000	-.00000	-.62500	5.50000	-.00000	-.62500
73	5.50000	.00000	-.62500	5.83300	.00000	-.62500	5.50000	.72041	-.50063	5.83300	.72041	-.50063
74	5.50000	.72041	-.50063	5.83300	.72041	-.50063	5.50000	1.25000	.00000	5.83300	1.25000	.00000
75	5.50000	1.25000	.00000	5.83300	1.25000	.00000	5.50000	.72041	.50063	5.83300	.72041	.50063
76	5.50000	.72041	.50063	5.83300	.72041	.50063	5.50000	-.00000	.62500	5.83300	-.00000	.62500
77	5.50000	-.00000	.62500	5.83300	-.00000	.62500	5.50000	-.72041	.50063	5.83300	-.72041	.50063
78	5.50000	-.72041	.50063	5.83300	-.72041	.50063	5.50000	-1.25000	.00000	5.83300	-1.25000	.00000
79	5.50000	-1.25000	.00000	5.83300	-1.25000	.00000	5.50000	-.72041	-.50063	5.83300	-.72041	-.50063
80	5.50000	-.72041	-.50063	5.83300	-.72041	-.50063	5.50000	-.00000	-.62500	5.83300	-.00000	-.62500
81	5.83300	.00000	-.62500	6.50000	.00000	-.62500	5.83300	.72041	-.50063	6.50000	.72041	-.50063
82	5.83300	.72041	-.50063	6.50000	.72041	-.50063	5.83300	1.25000	.00000	6.50000	1.25000	.00000
83	5.83300	1.25000	.00000	6.50000	1.25000	.00000	5.83300	.72041	.50063	6.50000	.72041	.50063
84	5.83300	.72041	.50063	6.50000	.72041	.50063	5.83300	-.00000	.62500	6.50000	-.00000	.62500
85	5.83300	-.00000	.62500	6.50000	-.00000	.62500	5.83300	-.72041	.50063	6.50000	-.72041	.50063
86	5.83300	-.72041	.50063	6.50000	-.72041	.50063	5.83300	-1.25000	.00000	6.50000	-1.25000	.00000
87	5.83300	-1.25000	.00000	6.50000	-1.25000	.00000	5.83300	-.72041	-.50063	6.50000	-.72041	-.50063
88	5.83300	-.72041	-.50063	6.50000	-.72041	-.50063	5.83300	-.00000	-.62500	6.50000	-.00000	-.62500
89	6.50000	.00000	-.62500	7.00000	.00000	-.62500	6.50000	.72041	-.50063	7.00000	.72041	-.50063
90	6.50000	.72041	-.50063	7.00000	.72041	-.50063	6.50000	1.25000	.00000	7.00000	1.25000	.00000
91	6.50000	1.25000	.00000	7.00000	1.25000	.00000	6.50000	.72041	.50063	7.00000	.72041	.50063
92	6.50000	.72041	.50063	7.00000	.72041	.50063	6.50000	-.00000	.62500	7.00000	-.00000	.62500
93	6.50000	-.00000	.62500	7.00000	-.00000	.62500	6.50000	-.72041	.50063	7.00000	-.72041	.50063
94	6.50000	-.72041	.50063	7.00000	-.72041	.50063	6.50000	-1.25000	.00000	7.00000	-1.25000	.00000
95	6.50000	-1.25000	.00000	7.00000	-1.25000	.00000	6.50000	-.72041	-.50063	7.00000	-.72041	-.50063
96	6.50000	-.72041	-.50063	7.00000	-.72041	-.50063	6.50000	-.00000	-.62500	7.00000	-.00000	-.62500
97	7.00000	.00000	-.62500	7.50000	.00000	-.62500	7.00000	.72041	-.50063	7.50000	.72041	-.50063
98	7.00000	.72041	-.50063	7.50000	.72041	-.50063	7.00000	1.25000	.00000	7.50000	1.25000	.00000
99	7.00000	1.25000	.00000	7.50000	1.25000	.00000	7.00000	.72041	.50063	7.50000	.72041	.50063
100	7.00000	.72041	.50063	7.50000	.72041	.50063	7.00000	-.00000	.62500	7.50000	-.00000	.62500
101	7.00000	-.00000	.62500	7.50000	-.00000	.62500	7.00000	-.72041	.50063	7.50000	-.72041	.50063
102	7.00000	-.72041	.50063	7.50000	-.72041	.50063	7.00000	-1.25000	.00000	7.50000	-1.25000	.00000
103	7.00000	-1.25000	.00000	7.50000	-1.25000	.00000	7.00000	-.72041	-.50063	7.50000	-.72041	-.50063
104	7.00000	-.72041	-.50063	7.50000	-.72041	-.50063	7.00000	-.00000	-.62500	7.50000	-.00000	-.62500
105	7.50000	.00000	-.62500	8.00000	.00000	-.62500	7.50000	.72041	-.50063	8.00000	.72041	-.50063
106	7.50000	.72041	-.50063	8.00000	.72041	-.50063	7.50000	1.25000	.00000	8.00000	1.25000	.00000
107	7.50000	1.25000	.00000	8.00000	1.25000	.00000	7.50000	.72041	.50063	8.00000	.72041	.50063
108	7.50000	.72041	.50063	8.00000	.72041	.50063	7.50000	-.00000	.62500	8.00000	-.00000	.62500
109	7.50000	-.00000	.62500	8.00000	-.00000	.62500	7.50000	-.72041	.50063	8.00000	-.72041	.50063
110	7.50000	-.72041	.50063	8.00000	-.72041	.50063	7.50000	-1.25000	.00000	8.00000	-1.25000	.00000
111	7.50000	-1.25000	.00000	8.00000	-1.25000	.00000	7.50000	-.72041	-.50063	8.00000	-.72041	-.50063
112	7.50000	-.72041	-.50063	8.00000	-.72041	-.50063	7.50000	-.00000	-.62500	8.00000	-.00000	-.62500
113	8.00000	.00000	-.62500	8.33300	.00000	-.62500	8.00000	.72041	-.50063	8.33300	.72041	-.50063

(y)

Figure 14.- Continued.

114	8,00000	,72041	-,50003	8,33300	,72041	-,50003	8,00000	1,25000	,00000	8,33300	1,25000	,00000
115	8,00000	1,25000	,00000	8,33300	1,25000	,00000	8,00000	,72041	,50003	8,33300	,72041	,50003
116	8,00000	,72041	,50003	8,33300	,72041	,50003	8,00000	-,00000	,62500	8,33300	-,00000	,62500
117	8,00000	-,00000	,62500	8,33300	-,00000	,62500	8,00000	-,72041	,50003	8,33300	-,72041	,50003
118	8,00000	-,72041	,50003	8,33300	-,72041	,50003	8,00000	-1,25000	,00000	8,33300	-1,25000	,00000
119	8,00000	-1,25000	,00000	8,33300	-1,25000	,00000	8,00000	-,72041	-,50003	8,33300	-,72041	-,50003
120	8,00000	-,72041	-,50003	8,33300	-,72041	-,50003	8,00000	-,00000	-,62500	8,33300	-,00000	-,62500
121	8,33300	,00000	-,62500	8,75000	,00000	-,62500	8,33300	,72041	-,50003	8,75000	,72041	-,50003
122	8,33300	,72041	-,50003	8,75000	,72041	-,50003	8,33300	1,25000	,00000	8,75000	1,25000	,00000
123	8,33300	1,25000	,00000	8,75000	1,25000	,00000	8,33300	,72041	,50003	8,75000	,72041	,50003
124	8,33300	,72041	,50003	8,75000	,72041	,50003	8,33300	-,00000	,62500	8,75000	-,00000	,62500
125	8,33300	-,00000	,62500	8,75000	-,00000	,62500	8,33300	-,72041	,50003	8,75000	-,72041	,50003
126	8,33300	-,72041	,50003	8,75000	-,72041	,50003	8,33300	-1,25000	,00000	8,75000	-1,25000	,00000
127	8,33300	-1,25000	,00000	8,75000	-1,25000	,00000	8,33300	-,72041	-,50003	8,75000	-,72041	-,50003
128	8,33300	-,72041	-,50003	8,75000	-,72041	-,50003	8,33300	-,00000	-,62500	8,75000	-,00000	-,62500
129	8,75000	,00000	-,62500	9,20000	,00000	-,62500	8,75000	,72041	-,50003	9,20000	,72041	-,50003
130	8,75000	,72041	-,50003	9,20000	,72041	-,50003	8,75000	1,25000	,00000	9,20000	1,25000	,00000
131	8,75000	1,25000	,00000	9,20000	1,25000	,00000	8,75000	,72041	,50003	9,20000	,72041	,50003
132	8,75000	,72041	,50003	9,20000	,72041	,50003	8,75000	-,00000	,62500	9,20000	-,00000	,62500
133	8,75000	-,00000	,62500	9,20000	-,00000	,62500	8,75000	-,72041	,50003	9,20000	-,72041	,50003
134	8,75000	-,72041	,50003	9,20000	-,72041	,50003	8,75000	-1,25000	,00000	9,20000	-1,25000	,00000
135	8,75000	-1,25000	,00000	9,20000	-1,25000	,00000	8,75000	-,72041	-,50003	9,20000	-,72041	-,50003
136	8,75000	-,72041	-,50003	9,20000	-,72041	-,50003	8,75000	-,00000	-,62500	9,20000	-,00000	-,62500
137	9,20000	,00000	-,62500	10,00000	,00000	-,62500	9,20000	,72041	-,50003	10,00000	,72041	-,50003
138	9,20000	,72041	-,50003	10,00000	,72041	-,50003	9,20000	1,25000	,00000	10,00000	1,25000	,00000
139	9,20000	1,25000	,00000	10,00000	1,25000	,00000	9,20000	,72041	,50003	10,00000	,72041	,50003
140	9,20000	,72041	,50003	10,00000	,72041	,50003	9,20000	-,00000	,62500	10,00000	-,00000	,62500
141	9,20000	-,00000	,62500	10,00000	-,00000	,62500	9,20000	-,72041	,50003	10,00000	-,72041	,50003
142	9,20000	-,72041	,50003	10,00000	-,72041	,50003	9,20000	-1,25000	,00000	10,00000	-1,25000	,00000
143	9,20000	-1,25000	,00000	10,00000	-1,25000	,00000	9,20000	-,72041	-,50003	10,00000	-,72041	-,50003
144	9,20000	-,72041	-,50003	10,00000	-,72041	-,50003	9,20000	-,00000	-,62500	10,00000	-,00000	-,62500

(z)

Figure 14.- Continued.

BODY PANEL CENTROID POINT COORDINATES, INCLINATION ANGLES AND AREAS

POINT	X CP	Y CP	Z CP	THETA RAD	DELTA RAD	AREA	THETA DEG	DELTA DEG
1	.83333	.00013	-.13000	-2.98279	.27666	.11200	-170.899	15.85100
2	.83333	.20240	-.00201	-2.37068	.38114	.11570	-135.830	21.83700
3	.83333	.20240	.00201	-.77091	.38114	.11570	-44.170	21.83700
4	.83333	.00013	.13000	-.15884	.27666	.11200	-9.101	15.85100
5	.83333	-.00013	.13000	.15884	.27666	.11200	9.101	15.85100
6	.83333	-.20240	.00201	.77091	.38114	.11570	44.170	21.83700
7	.83333	-.20240	-.00201	2.37068	.38114	.11570	135.830	21.83700
8	.83333	-.00013	-.13000	2.98279	.27666	.11200	170.899	15.85100
9	1.25000	.10770	-.20302	-2.98279	.20709	.30352	-170.899	11.86757
10	1.25000	.51000	-.13107	-2.37068	.18326	.30749	-135.830	10.50001
11	1.25000	.51000	.13107	-.77091	.18326	.30749	-44.170	10.50001
12	1.25000	.10770	.20302	-.15884	.20709	.30352	-9.101	11.86757
13	1.25000	-.10770	.20302	.15884	.20709	.30352	9.101	11.86757
14	1.25000	-.51000	.13107	.77091	.18326	.30749	44.170	10.50001
15	1.25000	-.51000	-.13107	2.37068	.18326	.30749	135.830	10.50001
16	1.25000	-.10770	-.20302	2.98279	.20709	.30352	170.899	11.86757
17	2.01733	.20017	-.42007	-2.98279	.10008	.43003	-170.899	5.73416
18	2.01733	.73236	-.10068	-2.37068	.20557	.43002	-135.830	11.77019
19	2.01733	.73236	.10068	-.77091	.20557	.43002	-44.170	11.77019
20	2.01733	.20017	.42007	-.15884	.10008	.43003	-9.101	5.73416
21	2.01733	-.20017	.42007	.15884	.10008	.43003	9.101	5.73416
22	2.01733	-.73236	.10068	.77091	.20557	.43002	44.170	11.77019
23	2.01733	-.73236	-.10068	2.37068	.20557	.43002	135.830	11.77019
24	2.01733	-.20017	-.42007	2.98279	.10008	.43003	170.899	5.73416
25	2.70530	.31000	-.60037	-2.98279	.09728	.39035	-170.899	5.57370
26	2.70530	.87002	-.22400	-2.37068	.13047	.39016	-135.830	7.47540
27	2.70530	.87002	.22400	-.77091	.13047	.39016	-44.170	7.47540
28	2.70530	.31000	.60037	-.15884	.09728	.39035	-9.101	5.57370
29	2.70530	-.31000	.60037	.15884	.09728	.39035	9.101	5.57370
30	2.70530	-.87002	.22400	.77091	.13047	.39016	44.170	7.47540
31	2.70530	-.87002	-.22400	2.37068	.13047	.39016	135.830	7.47540
32	2.70530	-.31000	-.60037	2.98279	.09728	.39035	170.899	5.57370
33	3.25211	.34975	-.53958	-2.98279	.05952	.35070	-170.899	3.41024
34	3.25211	.94071	-.24210	-2.37068	.08390	.36060	-135.830	4.80737
35	3.25211	.94071	.24210	-.77091	.08390	.36060	-44.170	4.80737
36	3.25211	.34975	.53958	-.15884	.05952	.35070	-9.101	3.41024
37	3.25211	-.34975	.53958	.15884	.05952	.35070	9.101	3.41024
38	3.25211	-.94071	.24210	.77091	.08390	.36060	44.170	4.80737
39	3.25211	-.94071	-.24210	2.37068	.08390	.36060	135.830	4.80737
40	3.25211	-.34975	-.53958	2.98279	.05952	.35070	170.899	3.41024
41	3.75000	.35858	-.95960	-2.98279	.02799	.36127	-170.899	1.60347
42	3.75000	.97962	-.25100	-2.37068	.03843	.36000	-135.830	2.20205
43	3.75000	.97962	.25100	-.77091	.03843	.36000	-44.170	2.20205
44	3.75000	.35858	.95960	-.15884	.02799	.36127	-9.101	1.60347
45	3.75000	-.35858	.95960	.15884	.02799	.36127	9.101	1.60347
46	3.75000	-.97962	.25100	.77091	.03843	.36000	44.170	2.20205
47	3.75000	-.97962	-.25100	2.37068	.03843	.36000	135.830	2.20205
48	3.75000	-.35858	-.95960	2.98279	.02799	.36127	170.899	1.60347
49	4.25000	.30296	-.96661	-2.98279	.00178	.36757	-170.899	.10183
50	4.25000	.98740	-.29613	-2.37068	.00291	.36672	-135.830	.16672
51	4.25000	.98740	.29613	-.77091	.00291	.36672	-44.170	.16672
52	4.25000	.30296	.96661	-.15884	.00178	.36757	-9.101	.10183
53	4.25000	-.30296	.96661	.15884	.00178	.36757	9.101	.10183
54	4.25000	-.98740	.29613	.77091	.00291	.36672	44.170	.16672
55	4.25000	-.98740	-.29613	2.37068	.00291	.36672	135.830	.16672

(aa)

Figure 14.- Continued.

56	6.89050	-.36794	-.50041	2.90275	.00178	.30757	170.009	.10183
57	6.75000	.36120	-.50002	-2.90275	0.00000	.36783	-170.009	0.00000
58	6.75000	.98420	-.25032	-2.37009	0.00000	.36499	-135.030	0.00000
59	6.75000	.98420	.25032	-.77001	0.00000	.36499	-44.170	0.00000
60	6.75000	.36120	.50002	-.15006	0.00000	.36783	-9.101	0.00000
61	6.75000	-.36120	.50002	.15006	0.00000	.36783	9.101	0.00000
62	6.75000	-.98420	.25032	.77001	0.00000	.36499	44.170	0.00000
63	6.75000	-.98420	-.25032	2.37009	0.00000	.36499	135.030	0.00000
64	6.75000	-.36120	-.50002	2.90275	0.00000	.36783	170.009	0.00000
65	5.25000	.36120	-.50002	-2.90275	0.00000	.36783	-170.009	0.00000
66	5.25000	.98420	-.25032	-2.37009	0.00000	.36499	-135.030	0.00000
67	5.25000	.98420	.25032	-.77001	0.00000	.36499	-44.170	0.00000
68	5.25000	.36120	.50002	-.15006	0.00000	.36783	-9.101	0.00000
69	5.25000	-.36120	.50002	.15006	0.00000	.36783	9.101	0.00000
70	5.25000	-.98420	.25032	.77001	0.00000	.36499	44.170	0.00000
71	5.25000	-.98420	-.25032	2.37009	0.00000	.36499	135.030	0.00000
72	5.25000	-.36120	-.50002	2.90275	0.00000	.36783	170.009	0.00000
73	5.00050	.36120	-.50002	-2.90275	0.00000	.20490	-170.009	0.00000
74	5.00050	.98420	-.25032	-2.37009	0.00000	.20300	-135.030	0.00000
75	5.00050	.98420	.25032	-.77001	0.00000	.20300	-44.170	0.00000
76	5.00050	.36120	.50002	-.15006	0.00000	.20490	-9.101	0.00000
77	5.00050	-.36120	.50002	.15006	0.00000	.20490	9.101	0.00000
78	5.00050	-.98420	.25032	.77001	0.00000	.20300	44.170	0.00000
79	5.00050	-.98420	-.25032	2.37009	0.00000	.20300	135.030	0.00000
80	5.00050	-.36120	-.50002	2.90275	0.00000	.20490	170.009	0.00000
81	6.10050	.36120	-.50002	-2.90275	0.00000	.00000	-170.009	0.00000
82	6.10050	.98420	-.25032	-2.37009	0.00000	.00000	-135.030	0.00000
83	6.10050	.98420	.25032	-.77001	0.00000	.00000	-44.170	0.00000
84	6.10050	.36120	.50002	-.15006	0.00000	.00000	-9.101	0.00000
85	6.10050	-.36120	.50002	.15006	0.00000	.00000	9.101	0.00000
86	6.10050	-.98420	.25032	.77001	0.00000	.00000	44.170	0.00000
87	6.10050	-.98420	-.25032	2.37009	0.00000	.00000	135.030	0.00000
88	6.10050	-.36120	-.50002	2.90275	0.00000	.00000	170.009	0.00000
89	6.75000	.36120	-.50002	-2.90275	0.00000	.36783	-170.009	0.00000
90	6.75000	.98420	-.25032	-2.37009	0.00000	.36499	-135.030	0.00000
91	6.75000	.98420	.25032	-.77001	0.00000	.36499	-44.170	0.00000
92	6.75000	.36120	.50002	-.15006	0.00000	.36783	-9.101	0.00000
93	6.75000	-.36120	.50002	.15006	0.00000	.36783	9.101	0.00000
94	6.75000	-.98420	.25032	.77001	0.00000	.36499	44.170	0.00000
95	6.75000	-.98420	-.25032	2.37009	0.00000	.36499	135.030	0.00000
96	6.75000	-.36120	-.50002	2.90275	0.00000	.36783	170.009	0.00000
97	7.25000	.36120	-.50002	-2.90275	0.00000	.36783	-170.009	0.00000
98	7.25000	.98420	-.25032	-2.37009	0.00000	.36499	-135.030	0.00000
99	7.25000	.98420	.25032	-.77001	0.00000	.36499	-44.170	0.00000
100	7.25000	.36120	.50002	-.15006	0.00000	.36783	-9.101	0.00000
101	7.25000	-.36120	.50002	.15006	0.00000	.36783	9.101	0.00000
102	7.25000	-.98420	.25032	.77001	0.00000	.36499	44.170	0.00000
103	7.25000	-.98420	-.25032	2.37009	0.00000	.36499	135.030	0.00000
104	7.25000	-.36120	-.50002	2.90275	0.00000	.36783	170.009	0.00000
105	7.75000	.36120	-.50002	-2.90275	0.00000	.36783	-170.009	0.00000
106	7.75000	.98420	-.25032	-2.37009	0.00000	.36499	-135.030	0.00000
107	7.75000	.98420	.25032	-.77001	0.00000	.36499	-44.170	0.00000
108	7.75000	.36120	.50002	-.15006	0.00000	.36783	-9.101	0.00000
109	7.75000	-.36120	.50002	.15006	0.00000	.36783	9.101	0.00000
110	7.75000	-.98420	.25032	.77001	0.00000	.36499	44.170	0.00000
111	7.75000	-.98420	-.25032	2.37009	0.00000	.36499	135.030	0.00000
112	7.75000	-.36120	-.50002	2.90275	0.00000	.36783	170.009	0.00000
113	8.10050	.36120	-.50002	-2.90275	0.00000	.20490	-170.009	0.00000
114	8.10050	.98420	-.25032	-2.37009	0.00000	.20300	-135.030	0.00000
115	8.10050	.98420	.25032	-.77001	0.00000	.20300	-44.170	0.00000

(bb)

Figure 14.- Continued.

116	0.16050	.36320	.56082	-.15884	0.00000	.24404	-9.101	0.00000
117	0.16050	-.36320	.56082	.15884	0.00000	.24404	9.101	0.00000
118	0.16050	-.90820	.25432	.77091	0.00000	.24304	44.170	0.00000
119	0.16050	-.90820	-.25432	2.37069	0.00000	.24304	135.830	0.00000
120	0.16050	-.36320	-.56082	2.98279	0.00000	.24404	170.899	0.00000
121	0.50150	.36320	-.56082	-2.98279	0.00000	.30477	-170.899	0.00000
122	0.50150	.90820	-.25432	-2.37069	0.00000	.30444	-135.830	0.00000
123	0.50150	.90820	.25432	-.77091	0.00000	.30444	-44.170	0.00000
124	0.50150	.36320	.56082	-.15884	0.00000	.30477	-9.101	0.00000
125	0.50150	-.36320	.56082	.15884	0.00000	.30477	9.101	0.00000
126	0.50150	-.90820	.25432	.77091	0.00000	.30444	44.170	0.00000
127	0.50150	-.90820	-.25432	2.37069	0.00000	.30444	135.830	0.00000
128	0.50150	-.36320	-.56082	2.98279	0.00000	.30477	170.899	0.00000
129	0.97500	.36320	-.56082	-2.98279	0.00000	.33105	-170.899	0.00000
130	0.97500	.90820	-.25432	-2.37069	0.00000	.32849	-135.830	0.00000
131	0.97500	.90820	.25432	-.77091	0.00000	.32849	-44.170	0.00000
132	0.97500	.36320	.56082	-.15884	0.00000	.33105	-9.101	0.00000
133	0.97500	-.36320	.56082	.15884	0.00000	.33105	9.101	0.00000
134	0.97500	-.90820	.25432	.77091	0.00000	.32849	44.170	0.00000
135	0.97500	-.90820	-.25432	2.37069	0.00000	.32849	135.830	0.00000
136	0.97500	-.36320	-.56082	2.98279	0.00000	.33105	170.899	0.00000
137	1.00000	.36320	-.56082	-2.98279	0.00000	.50453	-170.899	0.00000
138	1.00000	.90820	-.25432	-2.37069	0.00000	.50304	-135.830	0.00000
139	1.00000	.90820	.25432	-.77091	0.00000	.50304	-44.170	0.00000
140	1.00000	.36320	.56082	-.15884	0.00000	.50453	-9.101	0.00000
141	1.00000	-.36320	.56082	.15884	0.00000	.50453	9.101	0.00000
142	1.00000	-.90820	.25432	.77091	0.00000	.50304	44.170	0.00000
143	1.00000	-.90820	-.25432	2.37069	0.00000	.50304	135.830	0.00000
144	1.00000	-.36320	-.56082	2.98279	0.00000	.50453	170.899	0.00000

STORE NO 10

COMBINED ANGLES OF ATTACK ** SOLVE **
ALPHAC0 0.0000 PHIC0 0.0000
ALPHA0 0.0000 BETA0 0.0000

VELOCITY ON BODY ** SOLVE **

MACH0 1.900 ALPHA0 0.000 PHI00 0.000

PANEL NO.	SOURCE STRENGTH	NORMAL BC VELOCITY
1	.23400	.27314
2	.20108	.37108
3	.20108	.37108
4	.23400	.27314
5	.23400	.27314
6	.20108	.37108
7	.20108	.37108
8	.23400	.27314
9	.17705	.20610
10	.23510	.28502
11	.23510	.28502
12	.17705	.20610
13	.17705	.20610
14	.23510	.28502

(cc)

Figure 14.- Continued.

15	.21316	.20902
16	.17765	.20016
17	.12305	.16015
18	.10870	.20412
19	.10870	.20412
20	.12305	.16015
21	.12305	.16015
22	.10870	.20412
23	.10870	.20412
24	.12305	.16015
25	.08000	.97120E-01
26	.12163	.13044
27	.12163	.13044
28	.08000	.97120E-01
29	.08000	.97120E-01
30	.12163	.13044
31	.12163	.13044
32	.08000	.97120E-01
33	.02336	.90089E-01
34	.00956	.83800E-01
35	.00956	.83800E-01
36	.02336	.90089E-01
37	.02336	.90089E-01
38	.00956	.83800E-01
39	.00956	.83800E-01
40	.02336	.90089E-01
41	.00206	.27902E-01
42	.01375	.30477E-01
43	.01375	.30477E-01
44	.00206	.27902E-01
45	.00206	.27902E-01
46	.01375	.30477E-01
47	.01375	.30477E-01
48	.00206	.27902E-01
49	.00017	.17773E-02
50	-.01502	.25000E-02
51	-.01502	.25000E-02
52	.00017	.17773E-02
53	.00017	.17773E-02
54	-.01502	.25000E-02
55	-.01502	.25000E-02
56	.00017	.17773E-02
57	.00857	0.
58	.01463	0.
59	.01463	0.
60	.00857	0.
61	.00857	0.
62	.01463	0.
63	.01463	0.
64	.00857	0.
65	.00027	0.
66	.00222	0.
67	.00222	0.
68	.00027	0.
69	.00027	0.
70	.00222	0.
71	.00222	0.
72	.00027	0.
73	-.00735	0.
74	-.00577	0.

(dd)

Figure 14.- Continued.

75	-.00577	0.
76	-.00733	0.
77	-.00733	0.
78	-.00577	0.
79	-.00577	0.
80	-.00733	0.
81	-.02053	0.
82	-.00705	0.
83	-.00705	0.
84	-.02053	0.
85	-.02053	0.
86	-.00705	0.
87	-.00705	0.
88	-.02053	0.
89	-.00278	0.
90	.00606	0.
91	.00606	0.
92	-.00278	0.
93	-.00278	0.
94	.00646	0.
95	.00646	0.
96	-.00278	0.
97	.03301	0.
98	.02357	0.
99	.02357	0.
100	.03301	0.
101	.03301	0.
102	.02357	0.
103	.02357	0.
104	.03301	0.
105	.00705	0.
106	.00714	0.
107	.00714	0.
108	.00705	0.
109	.00705	0.
110	.00714	0.
111	.00714	0.
112	.00705	0.
113	-.01677	0.
114	-.01043	0.
115	-.01043	0.
116	-.01677	0.
117	-.01677	0.
118	-.01043	0.
119	-.01043	0.
120	-.01677	0.
121	-.03428	0.
122	-.00911	0.
123	-.00911	0.
124	-.03428	0.
125	-.03428	0.
126	-.00911	0.
127	-.00911	0.
128	-.03428	0.
129	.00140	0.
130	-.00272	0.
131	-.00272	0.
132	.00150	0.
133	.00150	0.
134	-.00272	0.

(ee)

Figure 14.- Continued.

135	-,00272	0,
136	,00150	0,
137	,03856	0,
138	,02649	0,
139	,02649	0,
140	,03856	0,
141	,03856	0,
142	,02649	0,
143	,02649	0,
144	,03856	0,

STORE SHOCK WAVE SHAPE

NOSE TIP SHOCK ANGLE = 54,000

MODIFIED SHOCK LOCATION, PHIS = 0,000 ** NSHOCK **

N	X	R	U	W	ML	BETA	DX/DR	DNU	UVRSQ
1	0,000	0,000	0,00000	0,00000	1,23607	,72054			
2	1,423	1,875	,01740	,09967	1,27549	,79161	,75908	6,20020	,85196
3	1,935	2,500	,02709	,08650	1,30904	,84475	,81818	5,33049	,86090
4	2,473	3,125	,03396	,07784	1,33139	,87094	,86186	4,73980	,87829
5	3,030	3,750	,03925	,07073	1,34796	,90329	,89113	4,30638	,88716
6	4,180	5,000	,04684	,06128	1,36979	,93611	,91970	3,70292	,90026
7	5,364	6,250	,05216	,05482	1,38463	,95770	,94091	3,29500	,90962
8	7,792	8,750	,05920	,04633	1,40370	,98508	,97139	2,76520	,92238

MODIFIED SHOCK LOCATION, PHIS = 45,000 ** NSHOCK **

N	X	R	U	W	ML	BETA	DX/DR	DNU	UVRSQ
1	0,000	0,000	0,00000	0,00000	1,23607	,72054			
2	1,391	1,875	,00972	,10729	1,25456	,75758	,74206	6,72036	,83911
3	1,866	2,500	,02087	,09266	1,29309	,81981	,78069	5,74598	,85659
4	2,409	3,125	,02873	,08271	1,31822	,85800	,83035	5,00911	,86938
5	2,954	3,750	,03464	,07539	1,33620	,88625	,87257	4,61137	,87920
6	3,515	4,375	,03930	,06971	1,34986	,90670	,89068	4,24656	,88716
7	4,066	5,625	,04624	,06139	1,36968	,93568	,92116	3,71116	,89916
8	5,888	6,875	,05125	,05565	1,38313	,95594	,94561	3,33626	,90794

MODIFIED SHOCK LOCATION, PHIS = 90,000 ** NSHOCK **

N	X	R	U	W	ML	BETA	DX/DR	DNU	UVRSQ
1	0,000	0,000	0,00000	0,00000	1,23607	,72054			
2	1,362	1,875	,09674	,12092	1,23607	,72054	,72096	7,65080	,81067
3	2,335	3,125	,02156	,09000	1,29957	,82900	,77827	5,57779	,85734
4	3,409	4,375	,03419	,07493	1,33715	,88768	,85886	4,58603	,87831
5	4,530	5,625	,04219	,06555	1,35963	,92119	,90443	3,97083	,89203
6	5,709	6,875	,04786	,05899	1,37495	,94306	,93247	3,56137	,90189
7	8,100	9,375	,05567	,04921	1,39698	,97261	,95813	3,00828	,91566
8	10,556	11,875	,06058	,04446	1,40781	,99965	,98177	2,65026	,92456

COMBINED ANGLES OF ATTACK ** SOLVE **

(ff)

Figure 14.- Continued.

ALPHAC= 5.0000 PHIR= 0.0000
ALPHA= 5.0000 BETA= 0.0000

VELOCITY ON BODY

** SOLVE **

MACH= 1.800 ALPHA= 5.000 PHIR= 0.000

PANEL NO.	SOURCE STRENGTH	NORMAL RC VELOCITY
1	.30028	.35489
2	.35695	.42860
3	.16921	.31254
4	.08689	.18932
5	.08689	.18932
6	.16921	.31254
7	.35695	.42860
8	.30028	.35489
9	.33648	.28950
10	.30404	.34386
11	.09702	.22401
12	.01787	.12117
13	.01787	.12117
14	.09702	.22401
15	.30404	.34386
16	.33648	.28950
17	.31710	.23073
18	.34941	.20454
19	.02655	.14215
20	-.07014	.60444E-01
21	-.07014	.60444E-01
22	.02655	.14215
23	.34941	.20454
24	.31710	.23073
25	.31850	.18241
26	.30415	.19785
27	-.00181	.73994E-01
28	-.15105	.11106E-01
29	-.15105	.11106E-01
30	-.00181	.73994E-01
31	.30415	.19785
32	.31850	.18241
33	.25969	.14516
34	.27671	.14578
35	-.13816	.21192E-01
36	-.21315	-.20848E-01
37	-.21315	-.20848E-01
38	-.13816	.21192E-01
39	.27671	.14578
40	.25969	.14516
41	.27971	.11390
42	.24835	.10179
43	-.22196	-.23148E-01
44	-.27564	-.58149E-01
45	-.27564	-.58149E-01
46	-.22196	-.23148E-01
47	.24835	.10179
48	.27971	.11390

(gg)

Figure 14.- Continued.

49	.29025	.87829E-01
50	.23720	.65014E-01
51	-.26713	-.60016E-01
52	-.28195	-.88288E-01
53	-.28195	-.88288E-01
54	-.26713	-.60016E-01
55	.23720	.65014E-01
56	.29025	.87829E-01
57	.38502	.86059E-01
58	.27092	.62515E-01
59	-.25117	-.62515E-01
60	-.28806	-.86059E-01
61	-.28806	-.86059E-01
62	-.25117	-.62515E-01
63	.27092	.62515E-01
64	.38502	.86059E-01
65	.35801	.86059E-01
66	.27217	.62515E-01
67	-.26776	-.62515E-01
68	-.27778	-.86059E-01
69	-.27778	-.86059E-01
70	-.26776	-.62515E-01
71	.27217	.62515E-01
72	.35801	.86059E-01
73	.30219	.86059E-01
74	.27009	.62515E-01
75	-.29056	-.62515E-01
76	-.31679	-.86059E-01
77	-.31679	-.86059E-01
78	-.29056	-.62515E-01
79	.27009	.62515E-01
80	.30219	.86059E-01
81	.31741	.86059E-01
82	.27841	.62515E-01
83	-.29246	-.62515E-01
84	-.35631	-.86059E-01
85	-.35631	-.86059E-01
86	-.29246	-.62515E-01
87	.27841	.62515E-01
88	.31741	.86059E-01
89	.30043	.86059E-01
90	.28268	.62515E-01
91	-.26931	-.62515E-01
92	-.31682	-.86059E-01
93	-.31682	-.86059E-01
94	-.26931	-.62515E-01
95	.28290	.62515E-01
96	.30043	.86059E-01
97	.30195	.86059E-01
98	.29012	.62515E-01
99	-.25215	-.62515E-01
100	-.29498	-.86059E-01
101	-.29498	-.86059E-01
102	-.25215	-.62515E-01
103	.29012	.62515E-01
104	.30195	.86059E-01
105	.32181	.86059E-01
106	.27596	.62515E-01
107	-.26172	-.62515E-01
108	-.30657	-.86059E-01

(hh)

Figure 14.- Continued.

109	-.30457	-.86059E-01
110	-.26172	-.62519E-01
111	.27594	.62519E-01
112	.32181	.86059E-01
113	.27783	.86059E-01
114	.25795	.62519E-01
115	-.27872	-.62519E-01
116	-.31124	-.86059E-01
117	-.31124	-.86059E-01
118	-.27872	-.62519E-01
119	.25795	.62519E-01
120	.27783	.86059E-01
121	.27773	.86059E-01
122	.25560	.62519E-01
123	-.27376	-.62519E-01
124	-.34602	-.86059E-01
125	-.34602	-.86059E-01
126	-.27376	-.62519E-01
127	.25560	.62519E-01
128	.27773	.86059E-01
129	.29789	.86059E-01
130	.25778	.62519E-01
131	-.26321	-.62519E-01
132	-.29490	-.86059E-01
133	-.29490	-.86059E-01
134	-.26321	-.62519E-01
135	.25778	.62519E-01
136	.29789	.86059E-01
137	.33741	.86059E-01
138	.27923	.62519E-01
139	-.23841	-.62519E-01
140	-.26058	-.86059E-01
141	-.26058	-.86059E-01
142	-.23841	-.62519E-01
143	.27923	.62519E-01
144	.33741	.86059E-01

(ii)

Figure 14.- Continued.

VORTEX-LATTICE PANEL CONTROL POINT COORDINATES,
INTERFERENCE VELOCITIES INDUCED AT THESE POINTS,
INPUT TWIST AND CAMBER SLOPE AT THESE POINTS,
AND PANEL SINGULARITY STRENGTHS
(WING COORDINATE SYSTEM)

WING CONTROL POINTS ROW	PANEL	X, FT	Y, FT	Z, FT	U/VINF	V/VINF	W/VINF	ALPHAL	GPLS/VINF
1	1	-1.90450	-4.99666	0.00000	-.01645	.06911	-.08076	0.00000	.11042
1	2	-3.37611	-4.99666	0.00000	-.01581	.07469	-.07835	0.00000	.08337
1	3	-4.78773	-4.99666	0.00000	-.05872	.07202	-.03642	0.00000	.04329
1	4	-6.19935	-4.99666	0.00000	.01202	.05984	-.10247	0.00000	.09601
1	5	-7.61096	-4.99666	0.00000	.01668	.06120	-.06649	0.00000	.05703
1	6	-9.02258	-4.99666	0.00000	.02971	.35466	-.05657	0.00000	.04420
1	7	-10.43420	-4.99666	0.00000	.00745	.05380	-.05633	0.00000	.04330
1	8	-11.84581	-4.99666	0.00000	-.00776	.07647	-.07487	0.00000	.04805
1	9	-13.25743	-4.99666	0.00000	-.02621	.08426	-.06649	0.00000	.04920
2	1	-3.16009	-6.10641	0.00000	-.01018	.02510	-.02921	0.00000	.12651
2	2	-4.50520	-6.10641	0.00000	-.09866	.07611	-.03268	0.00000	.09603
2	3	-5.85031	-6.10641	0.00000	-.03185	.34556	-.02678	0.00000	.06045
2	4	-7.19542	-6.10641	0.00000	.02896	.00869	-.06726	0.00000	.10378
2	5	-8.54054	-6.10641	0.00000	-.01969	.05261	-.04721	0.00000	.05777
2	6	-9.88565	-6.10641	0.00000	.01028	.00985	-.03746	0.00000	.04611
2	7	-11.23076	-6.10641	0.00000	.01970	.00157	-.03674	0.00000	.04410
2	8	-12.57588	-6.10641	0.00000	.00143	.02133	-.05096	0.00000	.05079
2	9	-13.92099	-6.10641	0.00000	-.00739	.03516	-.05424	0.00000	.05381
3	1	-4.93911	-7.75771	0.00000	-.03126	.02630	-.01936	0.00000	.15864
3	2	-6.18527	-7.75771	0.00000	-.03790	.03651	-.01916	0.00000	.10212
3	3	-7.43143	-7.75771	0.00000	-.05261	.04082	-.02232	0.00000	.07665
3	4	-8.67758	-7.75771	0.00000	.04070	-.02119	-.03952	0.00000	.09857
3	5	-9.92374	-7.75771	0.00000	.01480	-.00636	-.03301	0.00000	.06903
3	6	-11.16989	-7.75771	0.00000	.01150	-.00251	-.02457	0.00000	.04792
3	7	-12.41605	-7.75771	0.00000	.03247	-.01612	-.02255	0.00000	.04607
3	8	-13.66220	-7.75771	0.00000	.03132	-.02791	-.02394	0.00000	.04674
3	9	-14.90836	-7.75771	0.00000	-.01048	.01820	-.03911	0.00000	.05927
4	1	-7.33090	-9.97778	0.00000	-.02786	.02366	-.01227	0.00000	.18982
4	2	-8.44401	-9.97778	0.00000	-.02628	.02110	-.01293	0.00000	.11724
4	3	-9.55713	-9.97778	0.00000	-.01241	.02642	-.01441	0.00000	.08851
4	4	-10.67024	-9.97778	0.00000	.01485	-.00615	-.02480	0.00000	.09960
4	5	-11.78336	-9.97778	0.00000	.00871	-.00557	-.02120	0.00000	.06092
4	6	-12.89647	-9.97778	0.00000	-.02268	.02429	-.01077	0.00000	.05864
4	7	-14.00959	-9.97778	0.00000	.01111	-.00962	-.01486	0.00000	.05020
4	8	-15.12270	-9.97778	0.00000	.01769	-.01811	-.01426	0.00000	.04970
4	9	-16.23581	-9.97778	0.00000	.01616	-.01752	-.01640	0.00000	.05320
5	1	-9.72212	-12.19733	0.00000	-.02130	.01769	-.01079	0.00000	.22296
5	2	-10.70222	-12.19733	0.00000	.01004	-.00928	-.01050	0.00000	.13452
5	3	-11.68233	-12.19733	0.00000	-.01450	.02160	-.00899	0.00000	.09698
5	4	-12.66243	-12.19733	0.00000	.01616	-.01275	-.01675	0.00000	.10094
5	5	-13.64254	-12.19733	0.00000	.01172	-.01166	-.01578	0.00000	.09386
5	6	-14.62264	-12.19733	0.00000	.00444	-.00417	-.01502	0.00000	.07580
5	7	-15.60275	-12.19733	0.00000	-.00499	.00594	-.00985	0.00000	.05805
5	8	-16.58285	-12.19733	0.00000	.03019	-.01116	-.01013	0.00000	.09303
5	9	-17.56295	-12.19733	0.00000	.01561	-.01797	-.00970	0.00000	.05303
6	1	-12.11115	-14.41884	0.00000	-.00068	.00627	-.00821	0.00000	.25657
6	2	-12.95836	-14.41884	0.00000	.00043	.00172	-.00562	0.00000	.15190
6	3	-13.80558	-14.41884	0.00000	-.01829	.02081	-.00577	0.00000	.11208
6	4	-14.65280	-14.41884	0.00000	-.01666	.01708	-.01016	0.00000	.13660
6	5	-15.50001	-14.41884	0.00000	.00531	-.00596	-.01208	0.00000	.10286
6	6	-16.34723	-14.41884	0.00000	-.00268	.00276	-.00998	0.00000	.09054
6	7	-17.19445	-14.41884	0.00000	.00513	-.00520	-.00963	0.00000	.07634

(jj)

Figure 14.- Continued.

6	8	-18.04166	-16.41684	0.00000	-.00513	.00513	-.00738	0.00000	.06259
6	9	-18.88808	-16.41684	0.00000	.00918	-.01096	-.00733	0.00000	.05742
7	1	-14.49964	-16.63185	0.00000	-.01124	.01426	-.00643	0.00000	.29585
7	2	-15.21400	-16.63185	0.00000	-.00502	.00537	-.00403	0.00000	.17496
7	3	-15.92836	-16.63185	0.00000	-.02180	.02324	-.00228	0.00000	.12071
7	4	-16.64272	-16.63185	0.00000	-.01595	.01678	-.00618	0.00000	.11424
7	5	-17.35708	-16.63185	0.00000	-.01272	.01397	-.00873	0.00000	.11073
7	6	-18.07143	-16.63185	0.00000	.00135	-.00208	-.00892	0.00000	.10460
7	7	-18.78579	-16.63185	0.00000	-.00380	.00364	-.00757	0.00000	.09418
7	8	-19.50015	-16.63185	0.00000	.00175	-.00285	-.00864	0.00000	.08257
7	9	-20.21451	-16.63185	0.00000	-.00531	.00481	-.00632	0.00000	.06681
8	1	-16.88550	-18.84642	0.00000	-.02433	.02638	-.00537	0.00000	.33821
8	2	-17.46715	-18.84642	0.00000	-.00739	.00717	-.00358	0.00000	.20388
8	3	-18.04880	-18.84642	0.00000	.01044	-.01297	-.00383	0.00000	.15593
8	4	-18.63044	-18.84642	0.00000	-.01677	.01745	-.00366	0.00000	.12805
8	5	-19.21209	-18.84642	0.00000	-.01389	.01457	-.00560	0.00000	.11015
8	6	-19.79373	-18.84642	0.00000	-.01200	.01270	-.00700	0.00000	.08062
8	7	-20.37538	-18.84642	0.00000	.00294	-.00414	-.00712	0.00000	.05980
8	8	-20.95703	-18.84642	0.00000	-.00135	.00051	-.00712	0.00000	.04341
8	9	-21.53867	-18.84642	0.00000	.00166	-.00293	-.00629	0.00000	.02845

PYLON CONTROL POINTS

ROW	PANEL	X, FT	Y, FT	Z, FT	V/VINF	UPLUS/VINF
1	1	-6.63995	0.00000	3.52065	0.00000	0.00000
1	2	-5.86095	0.00000	3.52065	0.00000	0.00000
2	1	-6.63995	0.00000	3.89580	0.00000	0.00000
2	2	-8.86095	0.00000	3.89580	0.00000	0.00000

FUSELAGE CONTROL POINTS

RING	PANEL	X, FT	Y, FT	Z, FT	V/VINF	W/VINF	UPLUS/VINF
1	1	-1.37233	-.58950	3.33300	0.00000	0.00000	-.00000
1	2	-1.37233	-1.97700	3.33300	0.00000	0.00000	-.00002
1	3	-1.37233	-3.19250	3.33300	0.00000	0.00000	-.00021
1	4	-1.37233	-3.82000	3.33300	0.00000	0.00000	-.00067
1	5	-1.37233	-4.23850	3.12450	0.00000	0.00000	-.00105
1	6	-1.37233	-4.44700	2.29150	0.00000	0.00000	-.00237
1	7	-1.37233	-4.44700	.83350	.01288	.05048	-.01446
1	8	-1.37233	-4.02850	0.00000	0.00000	0.00000	.01262
1	9	-1.37233	-3.19250	0.00000	0.00000	0.00000	.00386
1	10	-1.37233	-2.66940	-.53095	0.00000	0.00000	.00186
1	11	-1.37233	-2.26300	-1.51205	0.00000	0.00000	.00038
1	12	-1.37233	-1.51205	-2.26300	0.00000	0.00000	.00008
1	13	-1.37233	-.53095	-2.66940	0.00000	0.00000	.00002
2	1	-2.81688	-.58950	3.33300	0.00000	0.00000	-.00010
2	2	-2.81688	-1.97700	3.33300	0.00000	0.00000	-.00048
2	3	-2.81688	-3.19250	3.33300	0.00000	0.00000	-.00342
2	4	-2.81688	-3.82000	3.33300	0.00000	0.00000	-.00625
2	5	-2.81688	-4.23850	3.12450	0.00000	0.00000	-.00854
2	6	-2.81688	-4.44700	2.29150	.00174	.02816	-.01550
2	7	-2.81688	-4.44700	.83350	.[illegible]3137	.03432	-.05853
2	8	-2.81688	-4.02850	0.00000	0.00000	0.00000	.01783
2	9	-2.81688	-3.19250	0.00000	0.00000	0.00000	.01018
2	10	-2.81688	-2.66940	-.53095	.[illegible]222	-.00584	-.00034
2	11	-2.81688	-2.26300	-1.51205	0.00000	0.00000	.00127
2	12	-2.81688	-1.51205	-2.26300	0.00000	0.00000	.00057
2	13	-2.81688	-.53095	-2.66940	0.00000	0.00000	.00022
3	1	-4.26144	-.58950	3.33300	0.00000	0.00000	-.00076
3	2	-4.26144	-1.97700	3.33300	0.00000	0.00000	-.00226
3	3	-4.26144	-3.19250	3.33300	.00073	.01629	.00572
3	4	-4.26144	-3.82000	3.33300	.00626	.02439	.00372

(kk)

Figure 14.- Continued.

3	5	-4.26144	-4.23850	3.12450	.00596	.02092	-.00766
3	6	-4.26144	-4.44700	2.29150	.01274	.02074	-.00114
3	7	-4.26144	-4.44700	.03350	.03002	.02172	-.00963
3	8	-4.26144	-4.02850	0.00000	0.00000	0.00000	.01097
3	9	-4.26144	-3.19250	0.00000	0.00000	0.00000	.01015
3	10	-4.26144	-2.66940	-.53095	.02279	-.00471	.01569
3	11	-4.26144	-2.26300	-1.51205	.01030	-.01036	.00435
3	12	-4.26144	-1.51205	-2.26300	.00700	-.00532	.00146
3	13	-4.26144	-.53095	-2.66940	0.00000	0.00000	.00097
4	1	-5.70599	-.98950	3.33300	-.03702	-.02133	-.01579
4	2	-5.70599	-1.97700	3.33300	.01221	.01300	.00705
4	3	-5.70599	-3.19250	3.33300	.01190	.01071	-.00531
4	4	-5.70599	-3.82000	3.33300	.01101	.02166	-.01009
4	5	-5.70599	-4.23850	3.12450	.01126	.02336	-.02060
4	6	-5.70599	-4.44700	2.29150	.01598	.02099	-.03033
4	7	-5.70599	-4.44700	.03350	.02006	.00973	-.00240
4	8	-5.70599	-4.02850	0.00000	0.00000	0.00000	.01579
4	9	-5.70599	-3.19250	0.00000	0.00000	0.00000	.00978
4	10	-5.70599	-2.66940	-.53095	.02007	-.00335	.01052
4	11	-5.70599	-2.26300	-1.51205	.01700	-.00011	.01170
4	12	-5.70599	-1.51205	-2.26300	.01907	-.00957	.00602
4	13	-5.70599	-.53095	-2.66940	.01121	-.00739	.00357
5	1	-7.15055	-.98950	3.33300	-.02001	-.00006	.00565
5	2	-7.15055	-1.97700	3.33300	-.00936	.00741	-.01500
5	3	-7.15055	-3.19250	3.33300	.01256	.01026	-.01069
5	4	-7.15055	-3.82000	3.33300	.01229	.01012	-.02077
5	5	-7.15055	-4.23850	3.12450	.01270	.01046	-.03170
5	6	-7.15055	-4.44700	2.29150	.01535	.01191	-.03501
5	7	-7.15055	-4.44700	.03350	.01570	-.00136	-.03010
5	8	-7.15055	-4.02850	0.00000	0.00000	0.00000	.02909
5	9	-7.15055	-3.19250	0.00000	0.00000	0.00000	.02506
5	10	-7.15055	-2.66940	-.53095	.01409	-.00177	.02229
5	11	-7.15055	-2.26300	-1.51205	.01506	-.00593	.01150
5	12	-7.15055	-1.51205	-2.26300	.01105	-.00059	.00095
5	13	-7.15055	-.53095	-2.66940	.00132	-.01366	.01003
6	1	-8.59511	-.98950	3.33300	.03303	.03296	.01063
6	2	-8.59511	-1.97700	3.33300	-.01218	.01121	-.01056
6	3	-8.59511	-3.19250	3.33300	-.00402	.00722	-.02147
6	4	-8.59511	-3.82000	3.33300	.01129	.00942	-.02336
6	5	-8.59511	-4.23850	3.12450	.01107	.00095	-.02701
6	6	-8.59511	-4.44700	2.29150	.01219	.00262	-.03210
6	7	-8.59511	-4.44700	.03350	.00921	-.01100	-.02313
6	8	-8.59511	-4.02850	0.00000	0.00000	0.00000	.02701
6	9	-8.59511	-3.19250	0.00000	0.00000	0.00000	.02963
6	10	-8.59511	-2.66940	-.53095	-.00207	-.00190	.03303
6	11	-8.59511	-2.26300	-1.51205	-.00075	-.00505	.03213
6	12	-8.59511	-1.51205	-2.26300	-.00006	-.00929	.01094
6	13	-8.59511	-.53095	-2.66940	.00002	-.01196	.00730
7	1	-10.03966	-.98950	3.33300	-.01070	-.00400	-.03196
7	2	-10.03966	-1.97700	3.33300	.01009	.01319	.00182
7	3	-10.03966	-3.19250	3.33300	-.01090	.00031	-.00782
7	4	-10.03966	-3.82000	3.33300	-.00473	.00300	-.01361
7	5	-10.03966	-4.23850	3.12450	-.00192	-.00099	-.01719
7	6	-10.03966	-4.44700	2.29150	-.00779	-.01123	-.01525
7	7	-10.03966	-4.44700	.03350	-.01021	-.02133	-.02271
7	8	-10.03966	-4.02850	0.00000	0.00000	0.00000	.02099
7	9	-10.03966	-3.19250	0.00000	-.00991	-.01122	.02173
7	10	-10.03966	-2.66940	-.53095	-.01709	-.00099	.02773
7	11	-10.03966	-2.26300	-1.51205	-.00615	-.00186	.01020
7	12	-10.03966	-1.51205	-2.26300	-.00294	-.00506	.01718

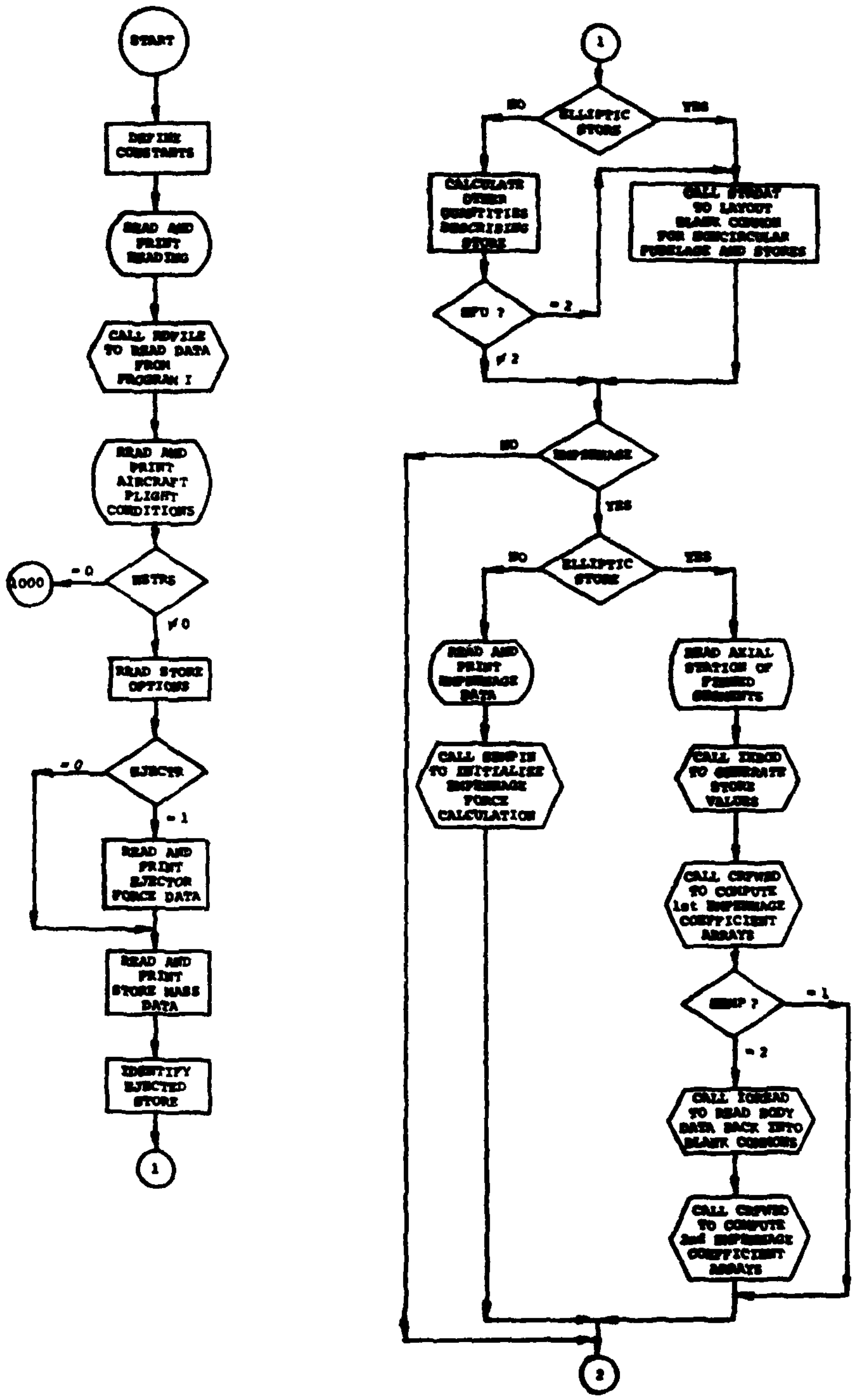
(11)

Figure 14.- Continued.

7	13	-10.83000	-.51095	-2.00000	-.00001	-.00020	.01502
8	1	-11.40422	-.58990	3.33100	-.00230	.00501	-.00770
8	2	-11.40422	-1.97700	3.33100	-.01061	.00209	-.02050
8	3	-11.40422	-3.19250	3.33100	.00019	.00200	-.01008
8	4	-11.40422	-3.82000	3.33100	.01072	.00109	-.01010
8	5	-11.40422	-4.23050	3.12050	.00050	-.00227	-.01728
8	6	-11.40422	-4.60700	2.29150	-.01010	-.01553	-.01007
8	7	-11.40422	-4.64700	.03350	-.03020	-.03210	.00000
8	8	-11.40422	-4.02050	0.00000	-.00059	-.00009	.00192
8	9	-11.40422	-3.19250	0.00000	-.00099	-.00570	.03755
8	10	-11.40422	-2.00000	-.53095	-.02222	-.00020	.03073
8	11	-11.40422	-2.20100	-1.51205	-.01515	-.00707	.03000
8	12	-11.40422	-1.51205	-2.20100	-.00000	-.01359	.03170
8	13	-11.40422	-.53095	-2.00000	-.00241	-.01213	.03070
9	1	-12.02877	-.58990	3.33100	-.00242	.00109	-.01001
9	2	-12.02877	-1.97700	3.33100	-.00022	-.00125	-.02131
9	3	-12.02877	-3.19250	3.33100	-.01715	-.00071	-.02707
9	4	-12.02877	-3.82000	3.33100	.00007	-.00003	-.02502
9	5	-12.02877	-4.23050	3.12050	.00030	-.01107	-.01077
9	6	-12.02877	-4.60700	2.29150	-.00170	-.01735	-.01007
9	7	-12.02877	-4.64700	.03350	-.01702	-.01722	-.00781
9	8	-12.02877	-4.02050	0.00000	.01000	.01502	.03500
9	9	-12.02877	-3.19250	0.00000	.01013	.01107	.03307
9	10	-12.02877	-2.00000	-.53095	-.01193	.02250	.02000
9	11	-12.02877	-2.20100	-1.51205	-.01110	.01115	.03201
9	12	-12.02877	-1.51205	-2.20300	-.00080	-.00001	.02000
9	13	-12.02877	-.53095	-2.00000	-.00310	-.00008	.02500

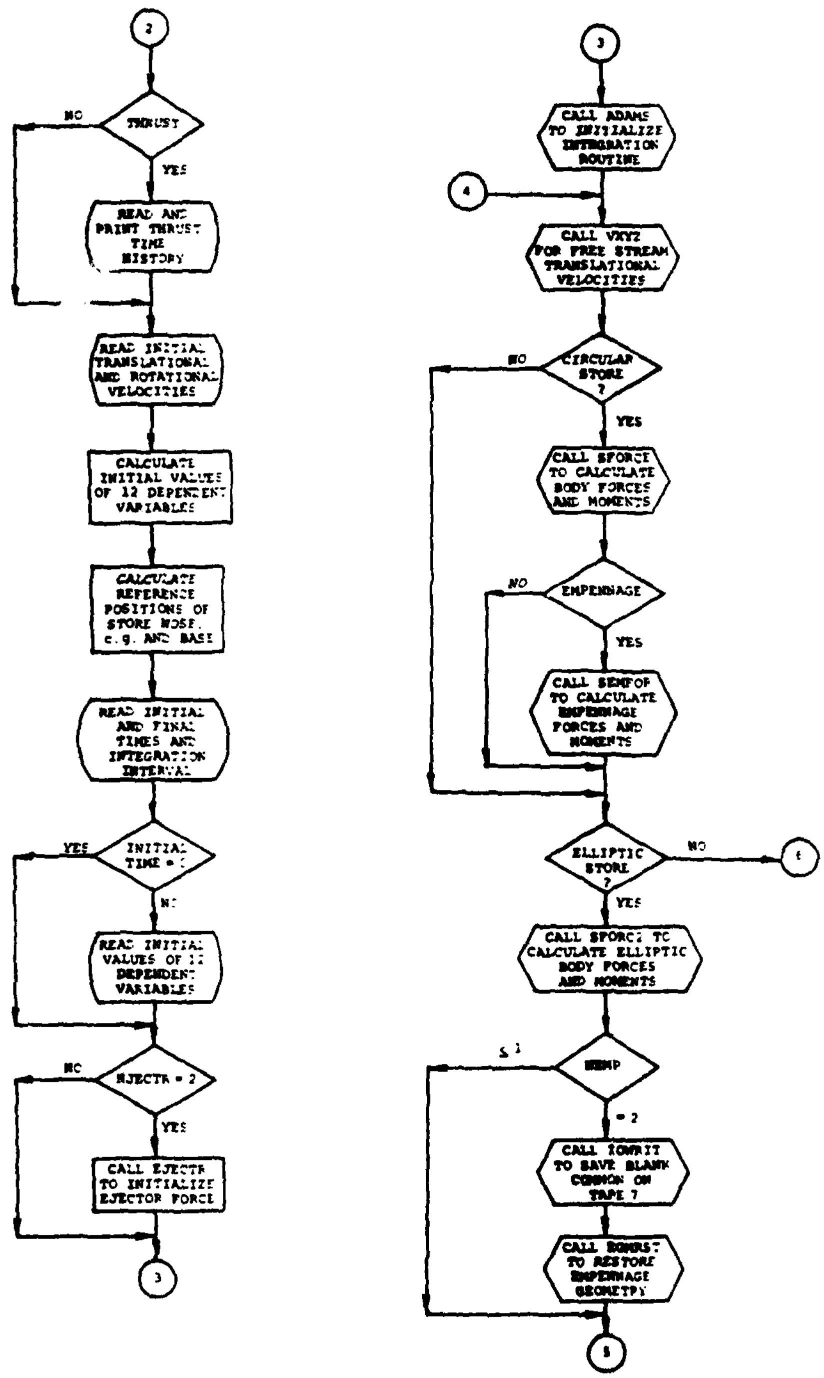
(mm)

Figure 14.- Concluded.



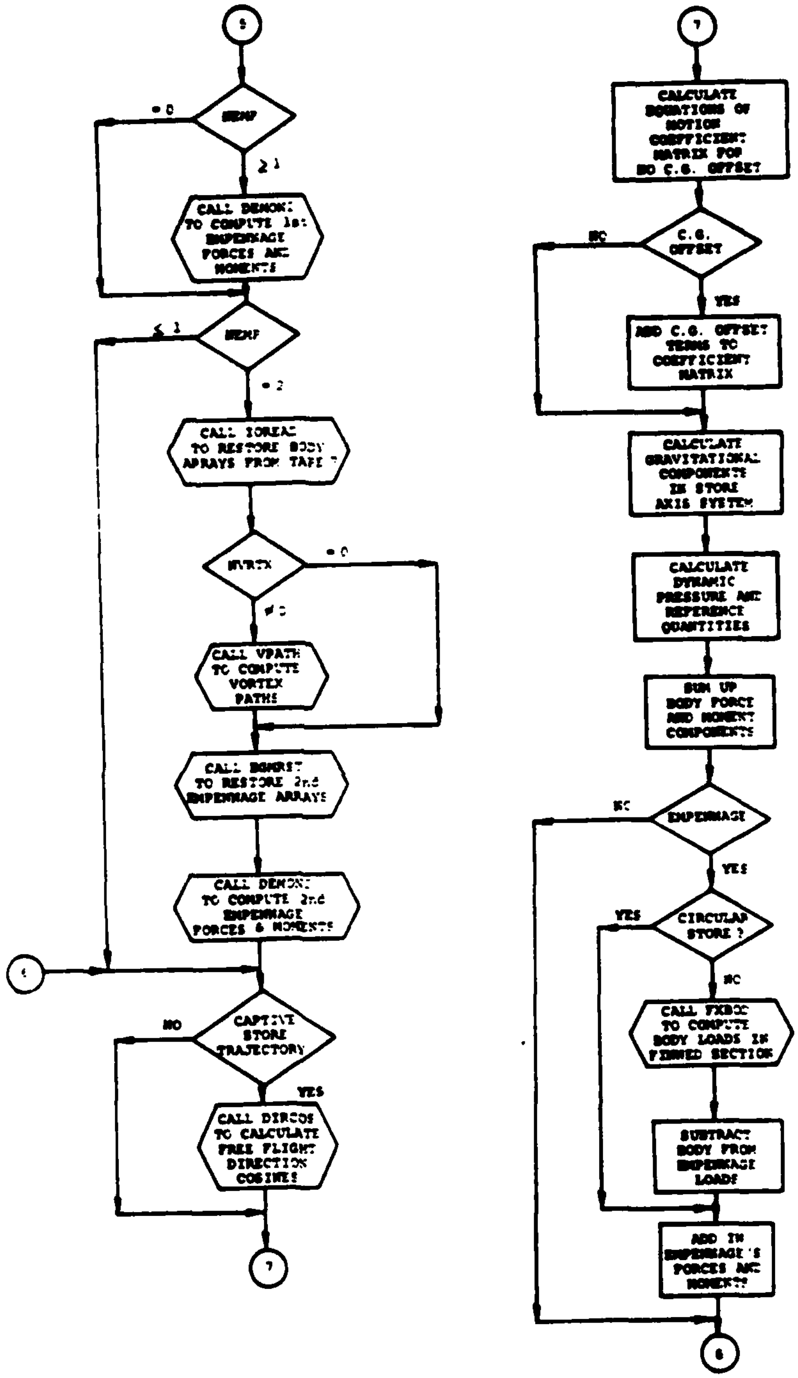
(a)

Figure 15.- General flow chart of Program II (TRJTRY).



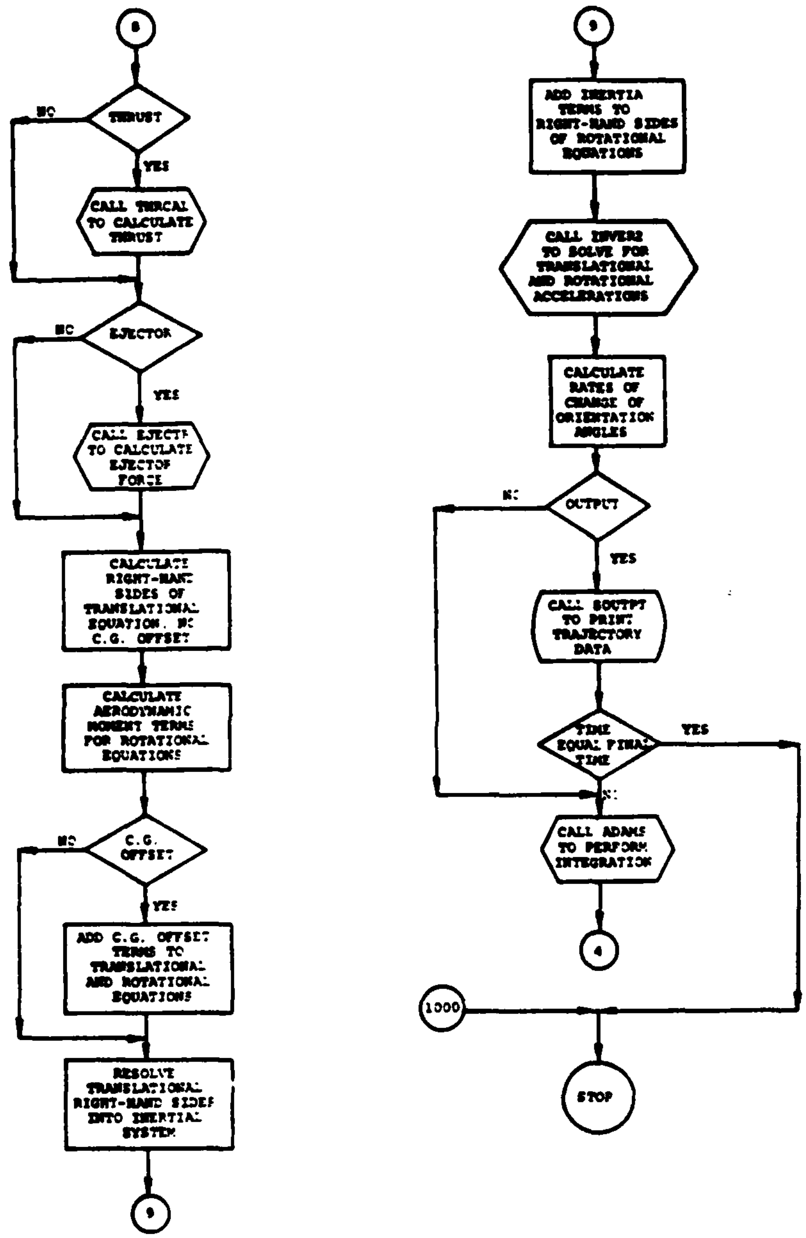
(b)

Figure 15.- Continued.



(c)

Figure 15.- Continued.



(d)

Figure 15.- Concluded.

Input PROGRAM 2 - TRJTRY

Item No. , (no. of cards), (Omissions), Routine read by:

Item No. 1 (1 card) TRJTRY

Variable	NCARDS	
Card Column	1 5	
Format Type	I	

Item No. 2 (NCARDS cards) TRJTRY

Variable	HEAD
Card Column	1 80
Format Type	20A4

Item No. 3 (1 card) TRJTRY

Variable	ALFA	GAMF	CMACH	RHO	VINF	
Card Column	1 10	20	30	40	50	
Format Type	F	F	F	F	F	

Item No. 4 (1 card) TRJTRY

Variable	NEJECT	NSEG	NSORCE	NGAM	NPOLY	NROLL	NEMP	NDAMP	NTHRUS	NTHETA	NJECTR
Card Column	1 5	10	15	20	25	30	35	40	45	50	55
Format Type											

Item No. 5 (1 card) (Omit if NJECTR = 0) EJECTR

Variable	NFEET	NSTRKE	
Card Column	1 5	10	
Format Type	I	I	

Include NFEET sets of items 6 and 7.

Item No. 6 (1 card) (Omit if NJECTR = 0) EJECTR

Variable	NEPOLY(I)	XE(I)	THETAE(I)	STROKE(I)	
Card Column	1 5	15	25	35	
Format Type	I	F	F	F	

Item No. 7 (1 card) (Omit if NJECTR = 0) EJECTR

Variable	TEEND(I,1)	TEEND(I,2)	TEEND(I,3)	TEEND(I,4)	TEEND(I,5)	
Card Column	10	20	30	40	50	
Format Type	F	F	F	F	F	

(a)

Figure 16.- Program II input formats.

Item No. 8 (NEPOLY(1) + NEPOLY(2) cards) (Omit if NEJECTR = 0) EJECTR

Variable	AKE(N,1)	AKE(N,2)	AKE(N,3)	AKE(N,4)	AKE(N,5)	AKE(N,6)	
Card Column	1 6	20	30	40	50	60	
Format Type	F	F	F	F	F	F	

Item No. 9 (1 card) TRJTRY

Variable	SMASS	FIXX	FIYY	FIZZ	FIYZ	FIXY	
Card Column	1 10	20	30	40	50	60	
Format Type	F	F	F	F	F	F	

Item No. 10 (1 card) TRJTRY

Variable	XMOM	XBAR	YBAR	ZBAR	
Card Column	1 10	20	30	40	
Format Type	F	F	F	F	

Item No. 11 (1 card. Omit if NSHAPE(NEJSTR) > 50) TRJTRY

Variable	XEND(1)	XEND(2)	....	XEND(NPOLY)				
Card Column	1 10	20			50	60	70	
Format Type	F	F		F	F	F	F	

Item No. 12 (J = 1 to NPOLY; NPOLY cards. Omit if NSHAPE(NEJSTR) > 50) TRJTRY

Variable	COEF(J,1)	COEF(J,2)	COEF(J,3)	COEF(J,4)	COEF(J,5)	COEF(J,6)	COEF(J,7)	
Card Column	1 10	20	30	40	50	60	70	
Format Type	F	F	F	F	F	F	F	

Item No. 13 (1 card) TRJTRY

Variable	CA	
Card Column	1 10	
Format Type	F	

Item No. 14 (1 card. Omit if NEMP = 0 or NSHAPE(NEJSTR) > 50) TRJTRY

Variable	IPLMF	MSF	
Card Column	1 5	10	
Format Type	I	I	

(b)

Figure 16.- Continued.

Item No. 15 (1 card. Omit if NEMP = 0 or NSHAPE(NEJSTR) > 50) TRJTRY

Variable	XTAIL	RADAV	FINSS	PHIROL	CLALPH	
Card Column	1 10	20	30	40	50	
Format Type	F	F	F	F	F	

Item No. 16 (1 card. Omit if NEMP = 0 or NSHAPE(NEJSTR) ≤ 50) TRJTRY

Variable	NBOD	XBOD(1)	XBOD(2)	XBOD(3)	XBOD(4)	XBOD(5)	LFIN(1)	LFIN(2)	LFIN(3)	LFIN(4)	LFIN(5)
Card Column	1 5	15	25	35	45	55	57	59	61	63	65
Format Type											

Omit items 17 thru 28, if NEMP = 0 or NSHAPE(NEJSTR) ≤ 50. Include NEMP sets of items. CRFWBD

Item No. 17 (1 card)

Variable	HEAD
Card Column	1 80
Format Type	20A4

CRFWBD

Item No. 18 (1 card)

Variable	MSWR	MSWL	MSWU	MSWO	NCW	NCWB	NBDCR	LVSWP	
Card Column	1 5	10	15	20	25	30	35	40	
Format Type	I	I	I	I	I	I	I	I	

CRFWBD

Item No. 19 (1 card)

Variable	CRP	SWLEP	SWTEP	B2	
Card Column	1 10	20	30	40	
Format Type	F	F	F	F	

CRFWBD

Item No. 20 (1 card. Omit if MSWU = 0 and MSWD = 0)

Variable	CRPV	SWLEV	SWTEV	B2V	
Card Column	1 10	20	30	40	
Format Type	F	F	F	F	

CRFWBD

Item No. 21 (1 card)

Variable	PHIDIH	THETIT	DELR	DELL	DELU	DELD	
Card Column	1 10	20	30	40	50	60	
Format Type	F	F	F	F	F	F	

(c)

Figure 16.- Continued.

Item No. 22 (1 card. Omit if $0 < THETIT < 90$) CRFWBD

Variable	PHIFR	PHIFL	PHIFU	PHIFD	THETR	THETL	THETU	THETD
Card Column	1 10	20	30	40	50	60	70	80
Format Type	F	F	F	F	F	F	F	F

Item No. 23 (1 card) CRFWBD

Variable	BIL	VRTMAX	
Card Column	1 10	20	
Format Type	F	F	

Item No. 24 (1 card) CRFWBD

Variable	NVRTIN	
Card Column	1 5	
Format Type	I	

Item No. 25 (MSWR + 1 cards. Omit if LVSWP = 0) CRFWBD

Variable	YRT(KJ)	VSWLER(KJ)	VSWTER(KJ)	
Card Column	1 10	20	30	
Format Type	F	F	F	

Item No. 26 (MSWL + 1 cards. Omit if LVSWP = 0 or MSWL = 0) CRFWBD

Variable	YLT(KJ)	YSWLEL(KJ)	VSWTEL(KJ)	
Card Column	1 10	20	30	
Format Type	F	F	F	

Item No. 27 (MSWU + 1 cards. Omit if LVSWP = 0 or MSWU = 0) CRFWBD

Variable	ZUT(KJ)	VSWLED(KJ)	VSWTED(KJ)	
Card Column	1 10	20	30	
Format Type	F	F	F	

Item No. 28 (MSWD + 1 cards. Omit if LVSWP = 0 or MSWD = 0) CRFWBD

Variable	ZDT(KJ)	VSWLED(KJ)	VSWTED(KJ)	
Card Column	1 10	20	30	
Format Type	F	F	F	

(d)

Figure 16.- Continued.

Item No. 29 (1 card. Omit if NTHRUS = 0) TRJTRY

Variable	NTPOLY	
Card Column	1 5	
Format Type	I	

Item No. 30 (1 card. Omit if NTHRUS = 0) TRJTRY

Variable	TEND(1)	TEND(2)	....	TEND(NTPOLY)			
Card Column	1 10	20			40	50	
Format Type	F	F		F	F	F	

Item No. 31 (J = 1, NTPOLY; NTPOLY cards. Omit if NTHRUS = 0) TRJTRY

Variable	TC(J,1)	TC(J,2)	TC(J,3)	TC(J,4)	TC(J,5)	TC(J,6)	
Card Column	1 10	20	30	40	50	60	
Format Type	F	F	F	F	F	F	

Item No. 32 (1 card) TRJTRY

Variable	VXZERO	VYZERO	VZZERO	VAR(4)	VAR(5)	VAR(6)	
Card Column	1 10	20	30	40	50	60	
Format Type	F	F	F	F	F	F	

Item No. 33 (1 card) TRJTRY

Variable	DTIME	TIMEI	TIMEF	
Card Column	1 10	20	30	
Format Type	F	F	F	

Item No. 34 (2 cards. Omit if TIMEI = 0) TRJTRY

Variable	VAR(1)	VAR(2)	....	VAR(12)				
Card Column	1 10	20	30	40	50	60	70	80
Format Type	F	F	F	F	F	F	F	F

(e)

Figure 16.- Concluded.

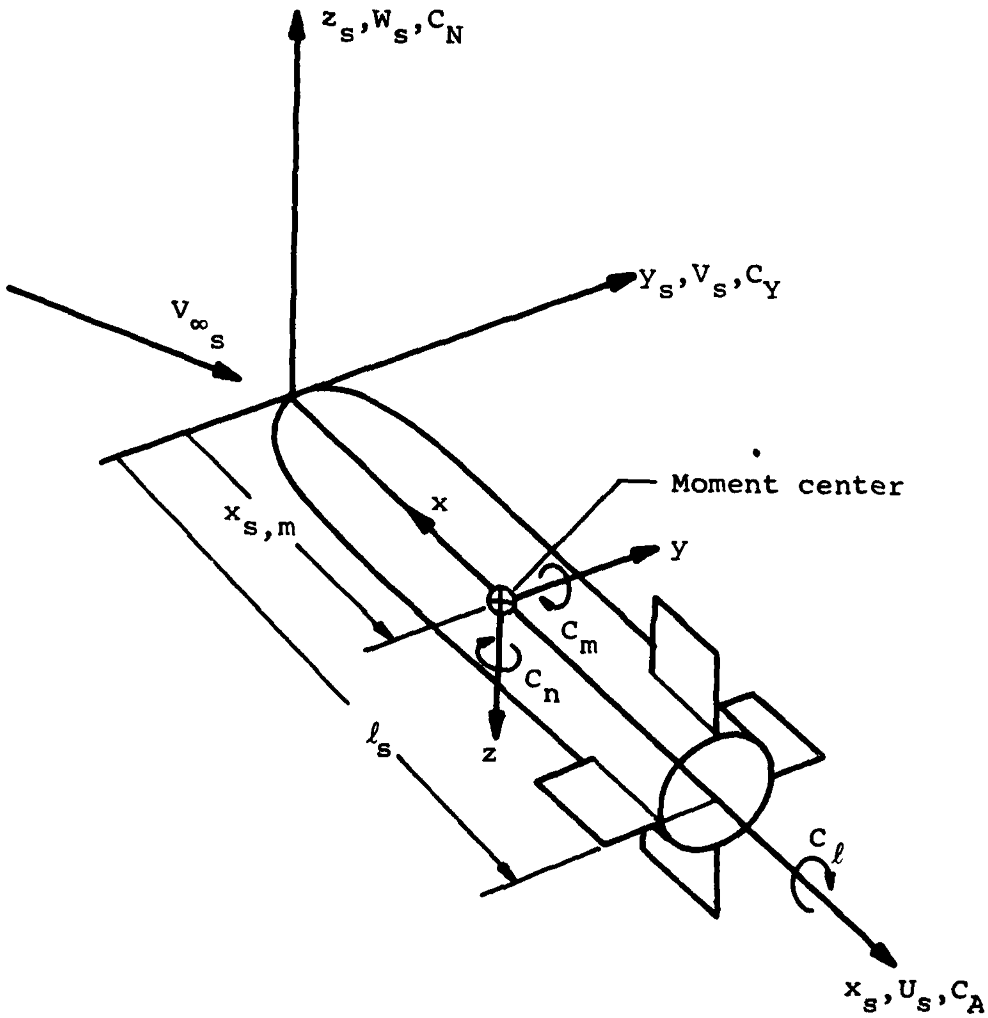
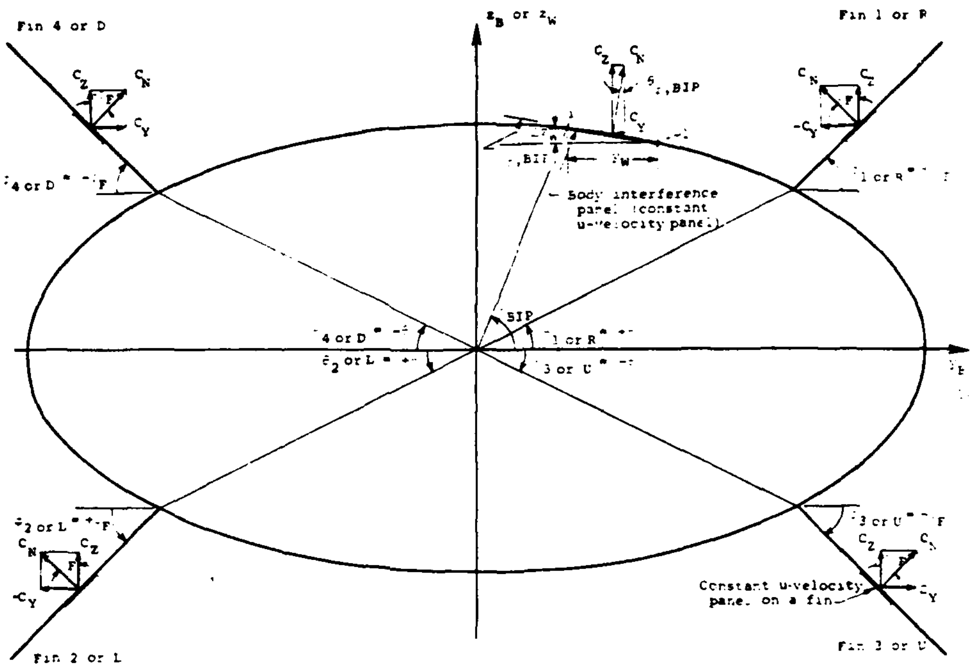


Figure 17.- Coordinate systems fixed in separated store and used in force and moment calculation.



ϕ_F = fin dihedral angle, PHIDIH

$\phi_{1 \text{ or } R}$ = dihedral angle of right upper fin, PHIFR=PHIDIH

$\phi_{2 \text{ or } L}$ = dihedral angle of left lower fin, PHIFL=PHIDIH

$\phi_{3 \text{ or } U}$ = dihedral angle of right lower fin, PHIFU= -PHIDIH

$\phi_{4 \text{ or } D}$ = dihedral angle of left upper fin, PHIFD= -PHIDIH

θ = fin location polar angle, THETIT

$\theta_{1 \text{ or } R}$ = polar angle of right upper fin, THETR=THETIT

$\theta_{2 \text{ or } L}$ = polar angle of left lower fin, THETL=THETIT

$\theta_{3 \text{ or } U}$ = polar angle of right lower fin, THETI= -THETIT

$\theta_{4 \text{ or } D}$ = polar angle of left upper fin, THETD= -THETIT

Body interference panels:

$\theta_{BIP,j}$ = THETI(J), $\Delta z_W = z_{W,j} - z_{W,j-1}$

$\Delta y_W = y_{W,j} - y_{W,j-1}$

$$\sin \delta_{2,BIP} = \frac{-\Delta z_W}{\sqrt{\Delta z_W^2 + \Delta y_W^2}}$$

$$\cos \delta_{2,BIP} = \frac{-\Delta y_W}{\sqrt{\Delta z_W^2 + \Delta y_W^2}}$$

these functions are used in the transformation (rotation) of the body interference panel to the reference (x_B, y_B, z_B) or (x_W, y_W, z_W) system

Figure 18.- Geometrical angles associated with case involving interdigitated fins on body with elliptical cross section and force coefficients associated with fins and body interference panel (view looking upstream).

```
 10                                                                          Item No.  1
NONCIRCULAR FUSELAGE (N3RP-A3) ELLIPTIC STORE AND FIN TRAJECTORY CALCULATION          2
  TWO ELLIPTIC STORE EMPENNAGES MODELED
      1ST IS MONOPLANE WING CONFIGURATION
      2ND IS FOUR INTERDIGITATED TAIL FINS AT 35 DEGREES
  TRAJECTORY START WITH STORE IN CARRIAGE POSITION
  ATMOSPHERIC FLIGHT CONDITIONS SIMULATE AN ALTITUDE OF 40,000 FT.
  THE AIRCRAFT IS IN LEVEL FLIGHT (FLIGHT PATH ANGLE EQUAL 0 DEG)
  THE TRAJECTORY SIMULATES THE EXPERIMENTAL CAPTIVE FLIGHT DATA
      TEST V6A, GROUP 365 (AFFDL TR 70-3130)
  ROLLING MOMENT IS CALCULATED
  NO AERODYNAMIC DAMPING IS INCLUDED
  NO VORTEX INFLUENCE IS INCLUDED ON AFT SET OF FINS
  NO POWER IS INCLUDED
  ONE EJECTOR IS PRESENT BASED ON DATA IN AFFDL TR 70-3130
5.0       0.0       1.5       0.0005852 1442.2                                        3
  10    0    0    1    0    1    2    0    0    0    1                                4
   1    0                                                                             5
   1 1.0       0.0       10.                                                          6
0.078                                                                                 7
0.0       1.0144E E5 2.68614E6-2.2209 E8 3.5906AE0-1.7000E10                          8
20.0      20.0      250.0     250.0     0.0       0.0       0.0                       9
5.00      0.0       0.0       0.0                                                    10
0.73                                                                                 13
   4 5.833   4.333     0.75      10.0                F T F T                         16
 1ST EMPENNAGE - MONOPLANE WING                                                      17
   4    4    0    0    5    5    0    0                                               18
2.5       53.13     0.0       1.25                                                   19
0.0       0.0       0.0       0.0       0.0       0.0                                21
0.0       0.0                           0.0       0.0                                22
2.5       0.35                                                                       23
   0                                                                                 24
 2ND EMPENNAGE - INTERDIGITATED TAIL                                                 17
   4    4    4    4    2    2    0    0                                               18
1.25      87.097    0.0       1.1483                                                 19
1.25      87.097    0.0       1.1483                                                 20
35.0      35.0      0.0       0.0       0.0       0.0                                21
1.25      0.35                                                                       23
   1                                                                                 24
 0.0      0.0       0.0       0.0       0.0       0.0                                32
0.078     0.0       0.0                                                              33
```

Figure 19.- Program II sample input case.

```
                         SUPERSONIC SIX-DEGREE-OF-FREEDOM TRAJECTORY PROGRAM

  WIND TUNNEL MODEL
    AIRCRAFT AND STORE ARE SCALED UP VERSIONS OF MODELS USED IN EXPERIMENTAL
         PROGRAM CONDUCTED IN CONJUNCTION WITH THIS WORK
    MODELS SCALED UP BY A FACTOR OF 20 TO APPROPRIATE FULL SCALE AIRCRAFT
    PARENT CONFIGURATION N3-B2-W-A8-(P3)C
    MACH NUMBER = 1.5
    ANGLE OF ATTACK =  5.0 DEGREES
    2 TO 1 ELLIPTIC STORE MODEL - SF
  NONCIRCULAR FUSELAGE (N3B2WA3) ELLIPTIC STORE AND FIN TRAJECTORY CALCULATION
    TWO ELLIPTIC STORE EMPENNAGES MODELED
         1ST IS MONOPLANE WING CONFIGURATION
         2ND IS FOUR INTERDIGITATED TAIL FINS AT 35 DEGREES
    TRAJECTORY START WITH STORE IN CARRIAGE POSITION
    ATMOSPHERIC FLIGHT CONDITIONS SIMULATE AN ALTITUDE OF 40,000 FT.
    THE AIRCRAFT IS IN LEVEL FLIGHT (FLIGHT PATH ANGLE EQUAL 0 DEG)
    THE TRAJECTORY SIMULATES THE EXPERIMENTAL CAPTIVE FLIGHT DATA
         TEST VA4, GROUP 3A3 (AEDC TR 79-3130)
    ROLLING MOMENT IS CALCULATED
    NO AERODYNAMIC DAMPING IS INCLUDED
    NO VORTEX INFLUENCE IS INCLUDED ON AFT SET OF FINS
    NO POWER IS INCLUDED
    ONE EJECTOR IS PRESENT BASED ON DATA IN AEDC TR 79-3130


AIRCRAFT FLIGHT CONDITIONS
     ANGLE OF ATTACK =  5.00 DEGREES
     FLIGHT PATH ANGLE =  0.00 DEGREES
     MACH NUMBER = 1.50
     FREE STREAM MASS DENSITY =   .0005882 SLUGS PER CUBIC FOOT
     FREE STREAM VELOCITY = 1452.20 FEET PER SECOND
```

(a)

Figure 20.- Program II output for sample case.

```
STORE NUMBER   1 IS THE STORE EJECTED
     STORE OPTIONS (0=NO,1=YES)
          CAPTIVE-STORE TRAJECTORY           NCAP =  1
          ROLLING MOMENT CALCULATED         NROLL =  1
          NUMBER OF EMPENNAGES PRESENT       NEMP =  2
          DAMPING INCLUDED IN FORCES        NDAMP =  0
          THRUST TIME HISTORY SPECIFIED    NTHRUS =  0
          EJECTOR FORCE HISTORY SPECIFIED  NJECTR =  1


EJECTOR FORCE DESCRIPTION
     NUMBER OF EJECTOR FEET (NFEET=)  1
     EJECTOR FORCE IS FUNCTION OF TIME (NSTRKE=0)

EJECTOR FOOT    1.  LOCATION AND POLYNOMIALS
     NUMBER OF POLYNOMIALS         (NEPOLY=)        1
     AXIAL LOCATION AFT OF NOSE      (XF=)   1.0000 FEET
     ROLL ORIENTATION             (THETAF=)     0.00 DEGREES
     STROKE LENGTH                (STRKF=)  10.0000 FEET
POLYNOMIALS SPECIFYING EJECTOR FORCE HISTORY
     TIME/LENGTH OF EACH SECTION
       SECTION  TEND
          1   .75000E-01

COEFFICIENTS OF POLYNOMIALS DESCRIBING SECTION
FOOT SECTION    C0            C1             C2            C3             C4            C5
  1       1 0.            141668.       .268618E+07 -.222090E+09  .352948E+10 -.170090E+11
     ADDITIONAL INPUT FOR THIS STORE
          STORE MASS =  20.00000 SLUGS
          MOMENTS AND PRODUCTS OF INERTIA, SLUG - SQ FT
             IXX =  20.00000
             IYY = 250.00000
             IZZ = 250.00000
             IYZ =   0.00000
             IXZ =   0.00000
             IXY =   0.00000
          STORE MOMENT CENTER IS  5.00000 FEET BEHIND NOSE
          STORE CENTER OF GRAVITY OFFSET FROM MOMENT CENTER, FEET
             XBAR =  0.00000
             YBAR =  0.00000
             ZBAR =  0.00000
          AXIAL-FORCE COEFFICIENT IS    .35000



          FINNED BODY LAYOUT
        STORE    FIN INDICATOR    ENDING
  I   X-STATION  T=FIN/F=BODY      RING
  1      5.833          F           11
  2      8.333          T           16
  3      8.750          F           17
  4     10.000          T           19


LEADING EDGE OF 1ST WING/EMPENNAGE (XWLE1) =     5.833
LEADING EDGE OF 2ND WING/EMPENNAGE (XWLE2) =     8.750
```

(b)

Figure 20.- Continued.

```
**************** 1ST EMPENNAGE - MONOPLANE WING                                         **************** PREWAR **

              EMPENNAGE INPUT GEOMETRY DESCRIPTION
          FIN PROPERTY                     FIN 1 OR 5    FIN 2 OR 6    FIN 3 OR 7    FIN 4 OR 8

NO. OF PANELS - SPANWISE        (NSW) =        4             4             0             0
BODY CHORD                       (CR) =      2.500         2.500         0.000         0.000
LEADING EDGE SWEEP             (SWLE) =     53.130        53.130         0.000         0.000
TRAILING EDGE SWEEP            (SWTE) =      0.000         0.000         0.000         0.000
EXPOSED SEMISPAN                 (B2) =      1.250         1.250         0.000         0.000
FIN DIHEDRAL                   (PHIF) =      0.000         0.000         0.000         0.000
BODY ANGLE OF FIN ATTACHMENT  (THETF) =      0.000         0.000         0.000         0.000
FIN DEFLECTION                  (DEL) =      0.000         0.000         0.000         0.000

          BODY PROPERTIES

VERTICAL SEMI PRINCIPAL AXIS     (BA) =      .6250
HORIZ. SEMI PRINCIPAL AXIS       (BB) =     1.2500
ELLIPTIC RATIO               (ERATIO) =     2.0000
INTERFERENCE BODY LENGTH        (BIL) =     2.5000
NO. OF PANELS AROUND BODY     (NBPCB) =     8
NO. OF STREAMWISE BODY PANELS (NCWB) =     4

          INTERDIGITATED ANGLES
   PHIDIG      THEDIG
  0.           0.

          REFERENCE
   SREF        RFFL
   2.6500      1.7678

          OPTIONAL
   NVSTIN    LVSWP     VSTMAX
     0          0   .39000
```

(c)

Figure 20.- Continued.

*************** 1ST [illegible] = MONOPLANE WING *************** [illegible] **

PANEL CORNER COORDINATES FOR WING PANELS

I	X	LF Y	Z	* X	LR Y	Z	* X	RF Y	Z	* X	RR Y	Z
				WING 1 PANELS								
1	0.0000	1.2500	0.0000 *	.5000	1.2500	0.0000 *	.4167	1.5625	0.0000 *	.8333	1.5625	0.0000
2	.5000	1.2500	0.0000 *	1.0000	1.2500	0.0000 *	.8333	1.5625	0.0000 *	1.2500	1.5625	0.0000
3	1.0000	1.2500	0.0000 *	1.5000	1.2500	0.0000 *	1.2500	1.5625	0.0000 *	1.6667	1.5625	0.0000
4	1.5000	1.2500	0.0000 *	2.0000	1.2500	0.0000 *	1.6667	1.5625	0.0000 *	2.0833	1.5625	0.0000
5	2.0000	1.2500	0.0000 *	2.5000	1.2500	0.0000 *	2.0833	1.5625	0.0000 *	2.5000	1.5625	0.0000
6	.4167	1.5625	0.0000 *	.8333	1.5625	0.0000 *	.8333	1.8750	0.0000 *	1.1667	1.8750	0.0000
7	.8333	1.5625	0.0000 *	1.2500	1.5625	0.0000 *	1.1667	1.8750	0.0000 *	1.5000	1.8750	0.0000
8	1.2500	1.5625	0.0000 *	1.6667	1.5625	0.0000 *	1.5000	1.8750	0.0000 *	1.8333	1.8750	0.0000
9	1.6667	1.5625	0.0000 *	2.0833	1.5625	0.0000 *	1.8333	1.8750	0.0000 *	2.1667	1.8750	0.0000
10	2.0833	1.5625	0.0000 *	2.5000	1.5625	0.0000 *	2.1667	1.8750	0.0000 *	2.5000	1.8750	0.0000
11	.8333	1.8750	0.0000 *	1.1667	1.8750	0.0000 *	1.2500	2.1875	0.0000 *	1.5000	2.1875	0.0000
12	1.1667	1.8750	0.0000 *	1.5000	1.8750	0.0000 *	1.5000	2.1875	0.0000 *	1.7500	2.1875	0.0000
13	1.5000	1.8750	0.0000 *	1.8333	1.8750	0.0000 *	1.7500	2.1875	0.0000 *	2.0000	2.1875	0.0000
14	1.8333	1.8750	0.0000 *	2.1667	1.8750	0.0000 *	2.0000	2.1875	0.0000 *	2.2500	2.1875	0.0000
15	2.1667	1.8750	0.0000 *	2.5000	1.8750	0.0000 *	2.2500	2.1875	0.0000 *	2.5000	2.1875	0.0000
16	1.2500	2.1875	0.0000 *	1.5000	2.1875	0.0000 *	1.6667	2.5000	0.0000 *	1.8333	2.5000	0.0000
17	1.5000	2.1875	0.0000 *	1.7500	2.1875	0.0000 *	1.8333	2.5000	0.0000 *	2.0000	2.5000	0.0000
18	1.7500	2.1875	0.0000 *	2.0000	2.1875	0.0000 *	2.0000	2.5000	0.0000 *	2.1667	2.5000	0.0000
19	2.0000	2.1875	0.0000 *	2.2500	2.1875	0.0000 *	2.1667	2.5000	0.0000 *	2.3333	2.5000	0.0000
20	2.2500	2.1875	0.0000 *	2.5000	2.1875	0.0000 *	2.3333	2.5000	0.0000 *	2.5000	2.5000	0.0000
				WING 2 PANELS								
21	.4167	-1.5625	0.0000 *	.8333	-1.5625	0.0000 *	0.0000	-1.2500	0.0000 *	.5000	-1.2500	0.0000
22	.8333	-1.5625	0.0000 *	1.2500	-1.5625	0.0000 *	.5000	-1.2500	0.0000 *	1.0000	-1.2500	0.0000
23	1.2500	-1.5625	0.0000 *	1.6667	-1.5625	0.0000 *	1.0000	-1.2500	0.0000 *	1.5000	-1.2500	0.0000
24	1.6667	-1.5625	0.0000 *	2.0833	-1.5625	0.0000 *	1.5000	-1.2500	0.0000 *	2.0000	-1.2500	0.0000
25	2.0833	-1.5625	0.0000 *	2.5000	-1.5625	0.0000 *	2.0000	-1.2500	0.0000 *	2.5000	-1.2500	0.0000
26	.8333	-1.8750	0.0000 *	1.1667	-1.8750	0.0000 *	.4167	-1.5625	0.0000 *	.8333	-1.5625	0.0000
27	1.1667	-1.8750	0.0000 *	1.5000	-1.8750	0.0000 *	.8333	-1.5625	0.0000 *	1.2500	-1.5625	0.0000
28	1.5000	-1.8750	0.0000 *	1.8333	-1.8750	0.0000 *	1.2500	-1.5625	0.0000 *	1.6667	-1.5625	0.0000
29	1.8333	-1.8750	0.0000 *	2.1667	-1.8750	0.0000 *	1.6667	-1.5625	0.0000 *	2.0833	-1.5625	0.0000
30	2.1667	-1.8750	0.0000 *	2.5000	-1.8750	0.0000 *	2.0833	-1.5625	0.0000 *	2.5000	-1.5625	0.0000
31	1.2500	-2.1875	0.0000 *	1.5000	-2.1875	0.0000 *	.8333	-1.8750	0.0000 *	1.1667	-1.8750	0.0000
32	1.5000	-2.1875	0.0000 *	1.7500	-2.1875	0.0000 *	1.1667	-1.8750	0.0000 *	1.5000	-1.8750	0.0000
33	1.7500	-2.1875	0.0000 *	2.0000	-2.1875	0.0000 *	1.5000	-1.8750	0.0000 *	1.8333	-1.8750	0.0000
34	2.0000	-2.1875	0.0000 *	2.2500	-2.1875	0.0000 *	1.8333	-1.8750	0.0000 *	2.1667	-1.8750	0.0000
35	2.2500	-2.1875	0.0000 *	2.5000	-2.1875	0.0000 *	2.1667	-1.8750	0.0000 *	2.5000	-1.8750	0.0000
36	1.6667	-2.5000	0.0000 *	1.8333	-2.5000	0.0000 *	1.2500	-2.1875	0.0000 *	1.5000	-2.1875	0.0000
37	1.8333	-2.5000	0.0000 *	2.0000	-2.5000	0.0000 *	1.5000	-2.1875	0.0000 *	1.7500	-2.1875	0.0000
38	2.0000	-2.5000	0.0000 *	2.1667	-2.5000	0.0000 *	1.7500	-2.1875	0.0000 *	2.0000	-2.1875	0.0000
39	2.1667	-2.5000	0.0000 *	2.3333	-2.5000	0.0000 *	2.0000	-2.1875	0.0000 *	2.2500	-2.1875	0.0000
40	2.3333	-2.5000	0.0000 *	2.5000	-2.5000	0.0000 *	2.2500	-2.1875	0.0000 *	2.5000	-2.1875	0.0000

(d)

Figure 20.- Continued.

RIB CORNER COORDINATES IN WING FRAME

I	X	LF Y	Z	X	LR Y	Z	X	RF Y	Z	X	RR Y	Z
41	0.0000	.7264	-.5086	.5000	.7264	-.5086	0.0000	0.0000	-.6250	.5000	0.0000	-.6250
42	0.0000	1.2500	.0000	.5000	1.2500	.0000	0.0000	.7264	-.5086	.5000	.7264	-.5086
43	0.0000	.7264	.5086	.5000	.7264	.5086	0.0000	1.2500	.0000	.5000	1.2500	.0000
44	0.0000	-.0000	.6250	.5000	-.0000	.6250	0.0000	.7264	.5086	.5000	.7264	.5086
45	0.0000	-.7264	.5086	.5000	-.7264	.5086	0.0000	-.0000	.6250	.5000	-.0000	.6250
46	0.0000	-1.2500	.0000	.5000	-1.2500	.0000	0.0000	-.7264	.5086	.5000	-.7264	.5086
47	0.0000	-.7264	-.5086	.5000	-.7264	-.5086	0.0000	-1.2500	.0000	.5000	-1.2500	.0000
48	0.0000	-.0000	-.6250	.5000	-.0000	-.6250	0.0000	-.7264	-.5086	.5000	-.7264	-.5086
49	.5000	.7264	-.5086	1.0000	.7264	-.5086	.5000	0.0000	-.6250	1.0000	0.0000	-.6250
50	.5000	1.2500	.0000	1.0000	1.2500	.0000	.5000	.7264	-.5086	1.0000	.7264	-.5086
51	.5000	.7264	.5086	1.0000	.7264	.5086	.5000	1.2500	.0000	1.0000	1.2500	.0000
52	.5000	-.0000	.6250	1.0000	-.0000	.6250	.5000	.7264	.5086	1.0000	.7264	.5086
53	.5000	-.7264	.5086	1.0000	-.7264	.5086	.5000	-.0000	.6250	1.0000	-.0000	.6250
54	.5000	-1.2500	.0000	1.0000	-1.2500	.0000	.5000	-.7264	.5086	1.0000	-.7264	.5086
55	.5000	-.7264	-.5086	1.0000	-.7264	-.5086	.5000	-1.2500	.0000	1.0000	-1.2500	.0000
56	.5000	-.0000	-.6250	1.0000	-.0000	-.6250	.5000	-.7264	-.5086	1.0000	-.7264	-.5086
57	1.0000	.7264	-.5086	1.5000	.7264	-.5086	1.0000	0.0000	-.6250	1.5000	0.0000	-.6250
58	1.0000	1.2500	.0000	1.5000	1.2500	.0000	1.0000	.7264	-.5086	1.5000	.7264	-.5086
59	1.0000	.7264	.5086	1.5000	.7264	.5086	1.0000	1.2500	.0000	1.5000	1.2500	.0000
60	1.0000	-.0000	.6250	1.5000	-.0000	.6250	1.0000	.7264	.5086	1.5000	.7264	.5086
61	1.0000	-.7264	.5086	1.5000	-.7264	.5086	1.0000	-.0000	.6250	1.5000	-.0000	.6250
62	1.0000	-1.2500	.0000	1.5000	-1.2500	.0000	1.0000	-.7264	.5086	1.5000	-.7264	.5086
63	1.0000	-.7264	-.5086	1.5000	-.7264	-.5086	1.0000	-1.2500	.0000	1.5000	-1.2500	.0000
64	1.0000	-.0000	-.6250	1.5000	-.0000	-.6250	1.0000	-.7264	-.5086	1.5000	-.7264	-.5086
65	1.5000	.7264	-.5086	2.0000	.7264	-.5086	1.5000	0.0000	-.6250	2.0000	0.0000	-.6250
66	1.5000	1.2500	.0000	2.0000	1.2500	.0000	1.5000	.7264	-.5086	2.0000	.7264	-.5086
67	1.5000	.7264	.5086	2.0000	.7264	.5086	1.5000	1.2500	.0000	2.0000	1.2500	.0000
68	1.5000	-.0000	.6250	2.0000	-.0000	.6250	1.5000	.7264	.5086	2.0000	.7264	.5086
69	1.5000	-.7264	.5086	2.0000	-.7264	.5086	1.5000	-.0000	.6250	2.0000	-.0000	.6250
70	1.5000	-1.2500	.0000	2.0000	-1.2500	.0000	1.5000	-.7264	.5086	2.0000	-.7264	.5086
71	1.5000	-.7264	-.5086	2.0000	-.7264	-.5086	1.5000	-1.2500	.0000	2.0000	-1.2500	.0000
72	1.5000	-.0000	-.6250	2.0000	-.0000	-.6250	1.5000	-.7264	-.5086	2.0000	-.7264	-.5086
73	2.0000	.7264	-.5086	2.5000	.7264	-.5086	2.0000	0.0000	-.6250	2.5000	0.0000	-.6250
74	2.0000	1.2500	.0000	2.5000	1.2500	.0000	2.0000	.7264	-.5086	2.5000	.7264	-.5086
75	2.0000	.7264	.5086	2.5000	.7264	.5086	2.0000	1.2500	.0000	2.5000	1.2500	.0000
76	2.0000	-.0000	.6250	2.5000	-.0000	.6250	2.0000	.7264	.5086	2.5000	.7264	.5086
77	2.0000	-.7264	.5086	2.5000	-.7264	.5086	2.0000	-.0000	.6250	2.5000	-.0000	.6250
78	2.0000	-1.2500	.0000	2.5000	-1.2500	.0000	2.0000	-.7264	.5086	2.5000	-.7264	.5086
79	2.0000	-.7264	-.5086	2.5000	-.7264	-.5086	2.0000	-1.2500	.0000	2.5000	-1.2500	.0000
80	2.0000	-.0000	-.6250	2.5000	-.0000	-.6250	2.0000	-.7264	-.5086	2.5000	-.7264	-.5086

(e)

Figure 20.- Continued.

```
*************** 2ND EMPENNAGE - INTERDIGITATED TAIL                                   ************** PRE-RUN **

                    EMPENNAGE INPUT GEOMETRY DESCRIPTION
           FIN PROPERTY                          FIN 1 OR B     FIN 2 OR L     FIN 3 OR U     FIN 4 OR R

NO. OF PANELS - SPANWISE         (NSW) =          4              4              4              4
ROOT CHORD                        (CR) =          1.250          1.250          1.250          1.250
LEADING EDGE SWEEP              (SWLE) =         47.427         47.427         47.427         47.427
TRAILING EDGE SWEEP             (SWTE) =          0.000          0.000          0.000          0.000
EXPOSED SEMISPAN                  (R2) =          1.188          1.188          1.188          1.188
FIN DIHEDRAL                    (DHIF) =         35.000         35.000        -35.000        -35.000
BODY ANGLE OF FIN ATTACHMENT   (THET) =          35.000         35.000        -35.000        -35.000
FIN DEFLECTION                   (DEL) =          0.000          0.000          0.000          0.000

              BODY PROPERTIES

VERTICAL SEMI PRINCIPAL AXIS    (RA) =         .6250
HORIZ. SEMI PRINCIPAL AXIS      (RB) =         1.2500
ELLIPTIC RATIO              (ERATIO) =         2.0000
INTERFERENCE BODY LENGTH       (RIL) =         1.2500
NO. OF PANELS AROUND BODY    (NBOCR) =         8
NO. OF STREAMWISE BODY PANELS(NCHB) =          2

              INTERDIGITATED ANGLES
      PHIDIN        THETII
      35.000        35.000

              REFERENCE
      BREF          REFL
      2.6500        1.7678

              OPTIONAL
      NVRTIN    IVANP     VRTMAX
         1         0      .35000
```

(f)

Figure 20.- Continued.

2ND EMPENNAGE - INTERDIGITATED TAIL ... CONFIG ..

PANEL CORNER COORDINATES FOR WING PANELS

I	X	LF Y	Z	X	LR Y	Z	X	RF Y	Z	X	RR Y	Z
WING 1 PANELS												
1	0.0000	.7264	.5086*	.6250	.7264	.5086*	.3125	.9616	.6733*	.7812	.9616	.6733
2	.6250	.7264	.5086*	1.2500	.7264	.5086*	.7812	.9616	.6733*	1.2500	.9616	.6733
3	.3125	.9616	.6733*	.7812	.9616	.6733*	.6250	1.1967	.8380*	.9375	1.1967	.8380
4	.7812	.9616	.6733*	1.2500	.9616	.6733*	.9375	1.1967	.8380*	1.2500	1.1967	.8380
5	.6250	1.1967	.8380*	.9375	1.1967	.8380*	.9375	1.4319	1.0026*	1.0937	1.4319	1.0026
6	.9375	1.1967	.8380*	1.2500	1.1967	.8380*	1.0937	1.4319	1.0026*	1.2500	1.4319	1.0026
7	.9375	1.4319	1.0026*	1.0937	1.4319	1.0026*	1.2499	1.6670	1.1673*	1.2500	1.6670	1.1673
8	1.0937	1.4319	1.0026*	1.2500	1.4319	1.0026*	1.2500	1.6670	1.1673*	1.2500	1.6670	1.1673
WING 2 PANELS												
9	.3125	-.9616	-.6733*	.7812	-.9616	-.6733*	0.0000	-.7264	-.5086*	.6250	-.7264	-.5086
10	.7812	-.9616	-.6733*	1.2500	-.9616	-.6733*	.6250	-.7264	-.5086*	1.2500	-.7264	-.5086
11	.6250	-1.1967	-.8380*	.9375	-1.1967	-.8380*	.3125	-.9616	-.6733*	.7812	-.9616	-.6733
12	.9375	-1.1967	-.8380*	1.2500	-1.1967	-.8380*	.7812	-.9616	-.6733*	1.2500	-.9616	-.6733
13	.9375	-1.4319	-1.0026*	1.0937	-1.4319	-1.0026*	.6250	-1.1967	-.8380*	.9375	-1.1967	-.8380
14	1.0937	-1.4319	-1.0026*	1.2500	-1.4319	-1.0026*	.9375	-1.1967	-.8380*	1.2500	-1.1967	-.8380
15	1.2499	-1.6670	-1.1673*	1.2500	-1.6670	-1.1673*	.9375	-1.4319	-1.0026*	1.0937	-1.4319	-1.0026
16	1.2500	-1.6670	-1.1673*	1.2500	-1.6670	-1.1673*	1.0937	-1.4319	-1.0026*	1.2500	-1.4319	-1.0026
WING 3 PANELS												
17	0.0000	.7264	-.5086*	.6250	.7264	-.5086*	.3125	.9616	-.6733*	.7812	.9616	-.6733
18	.6250	.7264	-.5086*	1.2500	.7264	-.5086*	.7812	.9616	-.6733*	1.2500	.9616	-.6733
19	.3125	.9616	-.6733*	.7812	.9616	-.6733*	.6250	1.1967	-.8380*	.9375	1.1967	-.8380
20	.7812	.9616	-.6733*	1.2500	.9616	-.6733*	.9375	1.1967	-.8380*	1.2500	1.1967	-.8380
21	.6250	1.1967	.8380*	.9375	1.1967	-.8380*	.9375	1.4319	-1.0026*	1.0937	1.4319	-1.0026
22	.9375	1.1967	.8380*	1.2500	1.1967	-.8380*	1.0937	1.4319	-1.0026*	1.2500	1.4319	-1.0026
23	.9375	1.4319	-1.0026*	1.0937	1.4319	-1.0026*	1.2499	1.6670	-1.1673*	1.2500	1.6670	-1.1673
24	1.0937	1.4319	-1.0026*	1.2500	1.4319	-1.0026*	1.2500	1.6670	-1.1673*	1.2500	1.6670	-1.1673
WING 4 PANELS												
25	.3125	-.9616	.6733*	.7812	-.9616	.6733*	0.0000	-.7264	.5086*	.6250	-.7264	.5086
26	.7812	-.9616	.6733*	1.2500	-.9616	.6733*	.6250	-.7264	.5086*	1.2500	-.7264	.5086
27	.6250	-1.1967	.8380*	.9375	-1.1967	.8380*	.3125	-.9616	.6733*	.7812	-.9616	.6733
28	.9375	-1.1967	.8380*	1.2500	-1.1967	.8380*	.7812	-.9616	.6733*	1.2500	-.9616	.6733
29	.9375	-1.4319	1.0026*	1.0937	-1.4319	1.0026*	.6250	-1.1967	.8380*	.9375	-1.1967	.8380
30	1.0937	-1.4319	1.0026*	1.2500	-1.4319	1.0026*	.9375	-1.1967	.8380*	1.2500	-1.1967	.8380
31	1.2499	-1.6670	1.1673*	1.2500	-1.6670	1.1673*	.9375	-1.4319	1.0026*	1.0937	-1.4319	1.0026
32	1.2500	-1.6670	1.1673*	1.2500	-1.6670	1.1673*	1.0937	-1.4319	1.0026*	1.2500	-1.4319	1.0026

RIB CORNER COORDINATES IN WING FRAME

(g)

Figure 20.- Continued.

I	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z
33	0.0000	.7266	-.5000*	.6250	.7266	-.5000*	0.0000	0.0000	-.6250*	.6250	0.0000	-.6250
34	0.0000	1.2500	.0000*	.6250	1.2500	.0000*	0.0000	.7266	-.5000*	.6250	.7266	-.5000
35	0.0000	.7266	.5000*	.6250	.7266	.5000*	0.0000	1.2500	.0000*	.6250	1.2500	.0000
36	0.0000	-.0000	.6250*	.6250	-.0000	.6250*	0.0000	.7266	.5000*	.6250	.7266	.5000
37	0.0000	-.7266	.5000*	.6250	-.7266	.5000*	0.0000	-.0000	.6250*	.6250	-.0000	.6250
38	0.0000	-1.2500	.0000*	.6250	-1.2500	.0000*	0.0000	-.7266	.5000*	.6250	-.7266	.5000
39	0.0000	-.7266	-.5000*	.6250	-.7266	-.5000*	0.0000	-1.2500	.0000*	.6250	-1.2500	.0000
40	0.0000	-.0000	-.6250*	.6250	-.0000	-.6250*	0.0000	-.7266	-.5000*	.6250	-.7266	-.5000
41	.6250	.7266	-.5000*	1.2500	.7266	-.5000*	.6250	0.0000	-.6250*	1.2500	0.0000	-.6250
42	.6250	1.2500	.0000*	1.2500	1.2500	.0000*	.6250	.7266	-.5000*	1.2500	.7266	-.5000
43	.6250	.7266	.5000*	1.2500	.7266	.5000*	.6250	1.2500	.0000*	1.2500	1.2500	.0000
44	.6250	-.0000	.6250*	1.2500	-.0000	.6250*	.6250	.7266	.5000*	1.2500	.7266	.5000
45	.6250	-.7266	.5000*	1.2500	-.7266	.5000*	.6250	-.0000	.6250*	1.2500	-.0000	.6250
46	.6250	-1.2500	.0000*	1.2500	-1.2500	.0000*	.6250	-.7266	.5000*	1.2500	-.7266	.5000
47	.6250	-.7266	-.5000*	1.2500	-.7266	-.5000*	.6250	-1.2500	.0000*	1.2500	-1.2500	.0000
48	.6250	-.0000	-.6250*	1.2500	-.0000	-.6250*	.6250	-.7266	-.5000*	1.2500	-.7266	-.5000

NOTE: L.E. OF LEAD PANEL IN FIRST CHORDWISE ROW IS SUPERSONIC

(h)

Figure 20.- Continued.

TIME = 0.00000 SECONDS

FORCE AND MOMENT COEFFICIENTS

	CN	CY	CLM	CLN	CLL
BODY	.38360	.00000	-.39753	.00000	-.00000
EMPENNAGE 1	-.09808	-.00000	.03673	.00000	.00000
EMPENNAGE 2	-.03187	-.00000	.05262	.00000	-.00000
TOTAL	.25366	-.00000	-.30817	.00000	-.00000

EJECTOR FORCES AND MOMENTS

FX	FZ	FY	MY	MZ	MX
0.000	0.000	0.000	0.000	0.000	0.000

LOAD DISTRIBUTIONS

X, FT	X/L	DCN/DX	DCY/DX
.93333	.05333	.02554	.00000
1.23608	.12341	.06368	.00000
2.01733	.20173	.01775	-.00000
2.70539	.27054	-.11854	-.00000
3.25211	.32521	-.10740	-.00000
3.75096	.37510	-.15849	-.00000
4.25006	.42501	-.09868	-.00000
4.75000	.47500	.15092	.00000
5.25000	.52500	.25262	-.00000
5.66650	.56665	.25256	.00000
6.16650	.61665	.34906	.00000
6.75000	.67500	.03376	-.00000
7.25000	.72500	-.05140	.00000
7.75000	.77500	-.07052	.00000
8.16650	.81665	.11601	.00000
8.56150	.85615	.15698	-.00000
8.97500	.89750	.23165	.00000
9.60000	.96000	-.11339	-.00000

LOCATION OF STORE IN FUSELAGE COORDINATE SYSTEM, DIMENSIONS OF FEET

	RELATIVE TO FUSELAGE NOSE			RELATIVE TO INITIAL POSITION		
	XF	YF	ZF	DEL XF	DEL YF	DEL ZF
NOSE	-27.45770	0.00000	4.70850	0.00000	0.00000	0.00000
XMOM	-32.45770	0.00000	4.70830	0.00000	0.00000	0.00000
BASE	-37.45770	0.00000	4.70830	0.00000	0.00000	0.00000

TRANSLATIONAL VELOCITIES AND ACCELERATIONS OF STORE IN FUSELAGE COORDINATE SYSTEM
RELATIVE TO FUSELAGE MOTION

DXF	DYF	DZF	D2XF	D2YF	D2ZF
0.00000	0.00000	0.00000	-58.80776	-.00000	12.57786

ROTATIONAL VELOCITIES AND ACCELERATIONS OF STORE IN STORE COORDINATE SYSTEM

P	Q	R	PDOT	QDOT	RDOT
0.00000	0.00000	0.00000	-.00000	-3.34598	.00000

STORE ANGULAR ORIENTATION IN FUSELAGE COORDINATE SYSTEM AND RATES OF CHANGE OF THESE ANGLES
ANGLES IN DEGREES, RATES OF CHANGE IN RADIANS PER SECOND

PSI	THETA	PHI	DPSI	DTHETA	DPHI
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

(i)

Figure 20.- Continued.

TIME = .30000 SECONDS

FORCE AND MOMENT COEFFICIENTS

	CN	CY	CLM	CLN	CLL
BODY	.23007	-.00000	.64677	-.00000	.00000
EMPENNAGE 1	.39282	.00000	-.53724	-.00000	-.00000
EMPENNAGE 2	.03469	.00000	-.12903	-.00000	-.00000
TOTAL	.66157	.00000	-.01951	-.00000	.00000

EJECTOR FORCES AND MOMENTS

FX	FZ	FY	MY	MZ	MX
0.000	0.000	0.000	0.000	0.000	0.000

LOAD DISTRIBUTIONS

X, FT	X/L	DCN/DX	DCY/DX
.53333	.05333	.04191	.00000
1.23608	.12361	.10580	.00000
2.01733	.20173	.15423	.00000
2.70539	.27054	.03832	.00000
3.25211	.32521	-.04378	.00000
3.75096	.37510	.02541	.00000
4.25006	.42501	.03602	.00000
4.75000	.47500	.04539	.00000
5.25000	.52500	.01116	.00000
5.66650	.56665	.03292	-.00000
6.16650	.61665	-.03013	-.00000
6.75000	.67500	-.07332	-.00000
7.25000	.72500	-.05035	-.00000
7.75000	.77500	.01242	-.00000
8.16650	.81665	.00605	.00000
8.54150	.85415	.14556	.00000
8.97500	.89750	.09193	-.00000
9.60000	.96000	-.16690	.00000

LOCATION OF STORE IN FUSELAGE COORDINATE SYSTEM, DIMENSIONS OF FEET

	RELATIVE TO FUSELAGE NOSE			RELATIVE TO INITIAL POSITION		
	XF	YF	ZF	DEL XF	DEL YF	DEL ZF
NOSE	-30.10150	.00000	6.97585	-2.72300	.00000	2.26755
XMOM	-35.10046	.00000	7.07787	-2.72276	.00000	2.36957
BASE	-40.17962	-.00000	7.17989	-2.72172	-.00000	2.47159

TRANSLATIONAL VELOCITIES AND ACCELERATIONS OF STORE IN FUSELAGE COORDINATE SYSTEM
RELATIVE TO FUSELAGE MOTION

DXF	DYF	DZF	D2XF	D2YF	D2ZF
-10.36074	.00000	3.65046	-59.07244	.00000	-17.50474

ROTATIONAL VELOCITIES AND ACCELERATIONS OF STORE IN STORE COORDINATE SYSTEM

P	Q	R	PDOT	QDOT	RDOT
.00000	-.40023	.00000	.00000	-.21100	-.00000

STORE ANGULAR ORIENTATION IN FUSELAGE COORDINATE SYSTEM AND RATES OF CHANGE OF THESE ANGLES
ANGLES IN DEGREES, RATES OF CHANGE IN RADIANS PER SECOND

PSI	THETA	PHI	DPSI	DTHETA	DPHI
.00000	1.16917	.00000	.00000	-.40023	.00000

(j)

Figure 20.- Continued.

TIME = .60000 SECONDS

FORCE AND MOMENT COEFFICIENTS

	CN	CY	CLM	CLN	CLL
BODY	.66283	.00000	.71695	-.00000	.00000
EMPENNAGE 1	.57403	.00000	-.69890	-.00000	-.00000
EMPENNAGE 2	.24647	.00000	-.62620	-.00000	.00000
TOTAL	1.20334	.00000	-.60815	-.00000	.00000

EJECTOR FORCES AND MOMENTS

FX	FZ	FY	MY	MZ	MX
0.000	0.000	0.000	0.000	0.000	0.000

LOAD DISTRIBUTIONS

X, FT	X/L	DCN/DX	DCY/DX
.53333	.05333	.04797	.00000
1.23600	.12361	.13078	.00000
2.01733	.20173	.10430	.00000
2.70539	.27054	.17570	.00000
3.25211	.32521	.13504	.00000
3.75096	.37510	.06376	.00000
4.25006	.42501	.03949	-.00000
4.75000	.47500	-.03986	.00000
5.25000	.52500	-.05095	.00000
5.66650	.56665	-.00750	-.00000
6.16650	.61665	-.02900	-.00000
6.75000	.67500	-.03294	-.00000
7.25000	.72500	-.03970	-.00000
7.75000	.77500	-.00421	-.00000
8.16650	.81665	-.05290	-.00000
8.54150	.85415	-.04555	.00000
8.97500	.89750	.02454	-.00000
9.60000	.96000	.09146	.00000

LOCATION OF STORE IN FUSELAGE COORDINATE SYSTEM, DIMENSIONS OF FEET

	RELATIVE TO FUSFLAGE NOSE			RELATIVE TO INITIAL POSITION		
	XF	YF	ZF	DEL XF	DEL YF	DEL ZF
NOSE	-38.37728	.00000	8.78272	-10.91950	.00000	4.07442
XMOM	-43.36685	.00000	9.10412	-10.90915	.00000	4.39582
BASE	-48.35651	.00000	9.42552	-10.89881	.00000	4.71722

TRANSLATIONAL VELOCITIES AND ACCELERATIONS OF STORE IN FUSELAGE COORDINATE SYSTEM
RELATIVE TO FUSELAGE MOTION

DXF	DYF	DZF	D2XF	D2YF	D2ZF
-36.30560	.00000	9.04160	-65.06503	.00000	-62.66660

ROTATIONAL VELOCITIES AND ACCELERATIONS OF STORE IN STORE COORDINATE SYSTEM

P	Q	R	PDOT	QDOT	RDOT
-.00000	.75274	.00000	.00000	-6.60296	-.00000

STORE ANGULAR ORIENTATION IN FUSELAGE COORDINATE SYSTEM AND RATES OF CHANGE OF THESE ANGLES
ANGLES IN DEGREES, RATES OF CHANGE IN RADIANS PER SECOND

PSI	THETA	PHI	DPSI	DTHETA	DPHI
.00000	3.60553	.00000	.00000	.75274	-.00000

PLEASE RETURN PAPER

(k)

Figure 20.- Concluded.

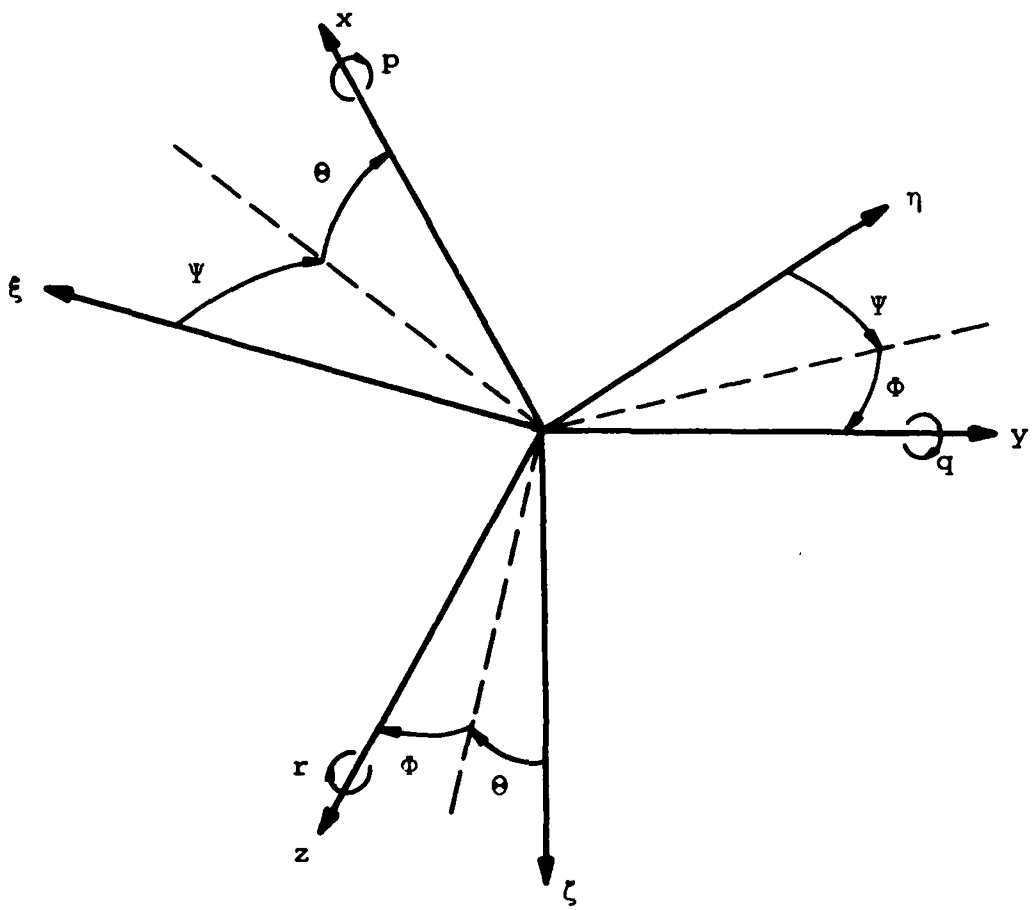


Figure 21.- Coordinate systems used in trajectory calculation.

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